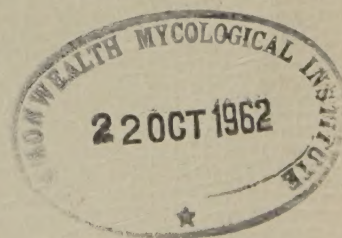
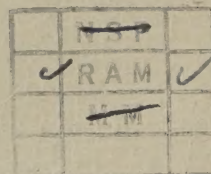


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UNITED PLANTERS' ASSOCIATION OF
SOUTHERN INDIA

SCIENTIFIC DEPARTMENT
(TEA SECTION)

ANNUAL
ADMINISTRATION REPORT
FOR
1961 - 62



NOTE :

Specimens for laboratory examination should be sent by *unregistered post* to

The Officer-in-Charge,
UPASI Tea Experiment Station,
Devarshola P. O.,
Nilgiris.

In the case of specimens too bulky to send by post, they should be sent by rail to Ootacamund and the Rail Receipt or Parcel Way Bills sent to

The Rajalakshmi Motor Service,
Ootacamund.

for collection and forwarding to Devarshola.

**UNITED PLANTERS' ASSOCIATION OF
SOUTHERN INDIA**

**SCIENTIFIC DEPARTMENT
(TEA SECTION)**

**ANNUAL
ADMINISTRATION REPORT
FOR
1961 - 62**

TEA PRODUCT SUB-COMMITTEE
(Up to September 1961)

MR. J. R. HENSHAW	<i>Chairman</i>
MR. C. H. S. LONDON	<i>Member (Chairman from December 1960 to May 1961)</i>
MR. C. V. SUBBU	<i>Member</i>
MR. H. C. KOTHARI	<i>(President, UPASI) Ex-Officio</i>
MR. W. C. F. SIMMONDS	<i>(Vice-President, UPASI) Ex-Officio (From March 1961)</i>

TEA PRODUCT SUB-COMMITTEE
(From September 1961)

MR. J. R. HENSHAW	<i>Chairman</i>
MR. C. H. S. LONDON	<i>Member</i>
MR. C. V. SUBBU	<i>Member</i>
MR. E. J. C. MENZIES	<i>Member</i>
MR. W. C. F. SIMMONDS	<i>(President UPASI) Ex-Officio</i>
MR. H. C. KOTHARI	<i>(Vice-President, UPASI) Ex-Officio</i>

SCIENTIFIC DEPARTMENT
TECHNICAL STAFF

MR. S. ANANDA RAU, M.Sc.	<i>Chief Scientific Officer</i>
MR. V. JAYARAMAN, B.A., B.Sc., (Ag.)	<i>Soil Chemist</i>
DR. K. S. VENKATARAMANI, M.Sc., Ph.D. F.B.S., F.R.H.S., F.L.S.	<i>Botanist</i>
DR. C. S. VENKATA RAM, M.Sc., M.S. (Minn) Ph.D., F.B.S.	<i>Plant Pathologist</i>
MR. N. R. ANANTHAKRISHNAN, B.Sc. (Hons.) Ag., A.I.A.R.I.	<i>Entomologist</i>
MR. T. N. RAMAKRISHNAN, M.Sc.,	<i>Asst. Soil Chemist</i>

OFFICE STAFF

MR. K. I. ABRAHAM	<i>Clerk—Devarshola</i>
MR. S. KAILASANATHAN	<i>Clerk—Coonoor (Resigned November 1961)</i>
MR. K. S. NANJUNDAN	<i>Clerk—Coonoor (Appointed November 1961)</i>
MR. M. MARIADAS	<i>Attender—Coonoor</i>

FIELD STAFF

MR. E. POWELL	<i>Field Recorder</i>
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LABORATORY ATTENDERS

MR. P. SANKARAN NAIR
MR. K. MADHAVAN CHETTY
MR. AHMED KUTTY

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United Planters' Association of Southern India

ANNUAL REPORT OF THE UPASI SCIENTIFIC DEPARTMENT

TEA SECTION

For 1st April 1961—31st March 1962

REPORT OF THE CHIEF SCIENTIFIC OFFICER

PART I—ADMINISTRATION

The Chief Scientific Officer continued to have his office at "Glenview", Coonoor, and the Soil Chemist was in day-to-day charge of the Tea Experiment Station at Devarshola.

Mr. S. Ananda Rau, Chief Scientific Officer, was superannuated on 31st May 1962 and reengaged on a contract for three years as from 1st June 1961.

Mr. V. Jayaraman, Soil Chemist, gave notice of retirement for reasons of ill-health. His retirement took effect on 31st March 1962, but he very kindly agreed to serve for two more months until a fresh Soil Chemist was appointed in his place.

The Botanist who moved to Coonoor at the beginning of the year was first stationed in a rented cottage in Quail Hill but later took up residence on Brooklands estate where a bungalow became vacant in close proximity to his nursery.

The Plant Pathologist was working at Devarshola and the Entomologist at Vandiperiyar.

Mr. S. Kailasanathan, clerk at Coonoor, resigned as from 1st November 1961 and Mr. K. S. Nanjundan was appointed in his place.

Tea Experiment Station, Devarshola : The usual upkeep of the Station buildings was maintained with no change.

The climatic conditions during the year were not entirely favourable to the growth of tea. The rainfall was 1205 mm. more than in 1960-61, but the excessive rain received during the monsoon was not helpful for harvesting increased crops. The dry weather months December to March were as usual almost dry and produced lower crops than in the previous year.

The crop of green leaf harvested during the year from the 5.29 hectares of tea was 35157 kg., a shortfall of 1631 kg. over the previous year. In terms of made tea calculated at an average outturn of 23%, the yield for the year was 1529 kg. per hectare as against 1611 kg. per hectare in 1960-61. The sale of green leaf at 29 nP. per pound (63.93 nP. per kg.) realised Rs. 22478.19 nP. which is Rs. 183.05 nP. less than the amount realised in the previous year.

The monthly distribution of crop during the year was as follows:—

MONTHLY CROP STATEMENT

		kg./green leaf	Average for past 5 years kg./green leaf
April	1961	1,955	2,009
May	"	3,711	2,911
June	"	4,726	3,255
July	"	3,375	4,047
August	"	3,271	3,439
September	"	4,107	4,326
October	"	3,593	4,011
November	"	3,562	4,388
December	"	2,939	2,643
January	1962	1,284	2,271
February	"	968	1,351
March	"	1,666	1,245
		<u>35,157</u>	<u>35,896</u>

The monthly yields from individual fields are given in the Table below.

MONTHLY FIELD YIELDS FOR 1961-62

(in kg./hectare)

Field Nos : Area (in hectares)	1926 (0.92)	1927 (0.32)	1928 (0.87)	1929 (0.50)	1930 (1.03)	Contour (0.62)	Old Tea (1.21)
1961:							
April	277.6	619.4	338.9	524.4	543.4	462.4	88.8
May	1396.8	976.7	732.0	460.0	500.7	1240.8	...
June	1768.1	938.4	737.2	1197.5	701.5	1076.9	138.7
July	640.5	720.1	572.5	413.7	701.5	834.0	504.6
August	834.2	707.3	677.8	219.5	469.0	801.9	456.2
September	919.0	1152.4	587.6	542.5	805.9	901.4	602.1
October	955.0	742.8	397.8	433.6	609.5	924.0	544.7
November	711.5	772.5	768.0	639.9	459.8	845.7	482.5
December	779.0	830.7	383.7	217.7	496.8	812.8	416.1
1962:							
January	468.4	267.9	115.2	147.9	98.7	228.3	322.8
February	164.2	269.3	92.8	156.0	121.1	428.0	182.2
March	511.3	292.0	415.5	169.6	221.1	504.1	222.4
	9425.6	8289.5	5819.0	5122.0	5729.0	9060.3	3961.1
Made Tea (in kg./hect.)	2168	1907	1338	1178	1318	2084	911

Correspondence: The increase in the volume of correspondence was referred to in last year's report. The year 1961-62 was no exception; in fact this year registered a substantial increase over the previous year. While it is a desirable feature in that it indicates greater use of the Department's services by the industry, it is nevertheless a big strain which perhaps will be mitigated when the station moves to the Anamallais where all officers work under one roof.

Publications: 11 research papers and 4 popular articles were prepared by the various officers of the Department. While most of them have been published, a few have been accepted and are awaiting publication. In addition, 9 articles of direct interest to tea have been included in the Appendix to this report.

A feature, started during the previous year, of writing short notes on current problems in the Planters' Chronicle was continued. During 1961-62, these notes appeared in 9 issues of the journal.

Touring: The following touring and visits were undertaken by the Chief Scientific Officer:

April	1961	...	Calcutta R. V. Estate, Nilgiris.
May	"	...	Havukal Estate, Nilgiris, Anamallais, Sutton Estate, Nilgiris.
June	"	...	Nonsuch Estate, Nilgiris, Kadamane Estate, Mysore, Periashola Estate, Nilgiri-Wynaad, Calcutta.
July	"	...	Prospect Estate, Nilgiris, Kodanaad Estate, Nilgiris, Calcutta.
August	"	...	Rousdonmullai Estate, Nilgiri-Wynaad.
September	"	...	Anamallais.
October November	}	"	...
December	"	...	High Range.
		...	Anamallais, Brooklands & Guernsey Estates, Nilgiris, Coffee Research Station, Mysore, Coimbatore.
January	1962	...	Devarshola Estate, Nilgiri-Wynaad, Central Travancore.

February	„	...	...
March	„	...	Ben Gorm Estate, Nilgiris, Anamallais, Calcutta.

It is to be noted that liaison visits to estates in plantation districts has not been a prominent feature of touring done during the year, but it is hoped to remedy the situation in the coming year.

The touring carried out by other officers of the Department is detailed in their respective reports which follow.

UPASI Exhibition : The Scientific Department, as usual, participated in the UPASI Exhibition and displayed exhibits of pests and diseases, technique of vegetative propagation and soil characteristics of different tea districts of South India.

VIII Annual Scientific Conference : This was held during the UPASI week in September 1961 and was well attended. In addition to official delegates from various District Planters' Associations, representatives of the I. T. A. Scientific Department, Tea Research Institute of Ceylon, Central Food Technological Research Institute, Mysore and Coffee Board Research Department attended and participated in the Conference. Full proceedings of the Conference were printed and published as Bulletin No. 20 of the Department.

Research Expansion Scheme : The construction of the laboratory in the Anamallais was almost complete at the end of the year except for certain items of interior work like partitions and flooring which are expected to be completed soon. No progress could unfortunately be made with the construction of staff quarters and other minor buildings as it was difficult to get any contractor to tender within the sanctioned estimates. At the suggestion of the Chairman, Tea Board, overhauling of all items of grant was undertaken with a view to approach Government for a total additional grant required to complete the scheme.

At the site of the Research Station an area of 1.09 hectares was planted with tea in 1961. Land was cleared and nurseries raised to plant up another 4 hectares in the planting season of 1962.

Construction work at the Vandiperiyar Sub-Station has made comparatively better progress. A senior officer's bungalow, a research assistant's quarters, a clerk's quarters and a labour line were in different stages of construction at the end of the year and it is hoped that they will all be completed within the next few months.

As regards the 44 cents of land adjoining the Sub-Station for acquiring which an application has been pending with the Kerala Government, it was understood that the Kerala Government was willing to lease it for 10 years. As the period of lease is rather short, the Tea Board is continuing its efforts to get the lease period extended to 30 years.

Boards, Committees and Conferences: The Chief Scientific Officer represented the UPASI on the following:—

1. Advisory Board of the Indian Council of Agricultural Research in the vacancy caused by the resignation of Mr. W. W. Mayne.
2. The Nilgiris District Soil Conservation Board.
3. The Tea Research Liaison Committee of the Tea Board.
4. Agricultural and Food Products Division Council of the Indian Standards Institution (alternate to I. T. A. representative).

The Chief Scientific Officer attended the Golden Jubilee of the Madras Agricultural College at Coimbatore in December 1961 and the second session of the Indian Academy of Agricultural Sciences held at the same time. He also participated in the Field Day of the Coffee Research Station at Balehonnur in December 1961.

Visitors: During the year under report the following overseas visitors were received either at Coonoor or Devarshola:—Mr. G. R. Moore of Stauffer Chemical Co., New York, a team of Russian Botanists led by Dr. J. C. Sengupta, Messrs. Boit and Von Krosigk of Ruhr-Stickstoff, West Germany, Mr. Misner of Rohm and Haas, U.S.A.; Mr. Brown, Nematologist of Shell Chemicals, U. K., Mr. Taylor of Fisons Pest Control, U.K., and Mr. de Geus of the Central Nitrogen Sales Organisation, Holland.

Commercial organisations of the country associated with planting were in close touch with us and we were happy to receive frequent visits from their representatives.

Finally, my colleagues and I had the unique pleasure of welcoming Mr. A. S. Bam, I.C.S., Chairman, Tea Board, at the Devarshola Station in September 1961.

PART II - ADVISORY AND RESEARCH.

A considerable part of the time of the technical staff was devoted to answering technical enquiries referred to us by member estates. This work which is naturally given top priority often involves disruption in the research work on hand, but the handicap is bound to exist as long as separate advisory staff are not there to deal with this aspect of work.

Soils : Despite statements repeatedly made both in our publications and in correspondence with estates, the fact appears to have not been fully appreciated that routine soil analysis is not likely to provide any clue for accounting for the condition of growth of tea or for basing manurial recommendation. During the year under report, a very large number of soil samples, particularly from one large group, was received and this gave us an opportunity to examine the acidity status of the South Indian tea soils in some detail. From the pH determination carried out on over 400 soil samples received from different districts, it is significant to note that over 80% of soils of South Indian tea areas fall within 4.6. to 6.0, a range considered optimum for satisfactory growth of tea. The same cannot be said of organic matter content, as quite a high percentage of soils was in need of improvement in this respect.

Manuring : Interest on this subject was fully maintained, as revealed by the number of enquiries received from estates, specially after the publication of the revised recommendations made by the Tea Research Institute of Ceylon. It is gratifying to be able to record that in these recommendations the amount of phosphoric acid has been pegged down to 30 lb. per acre which we in South India have been advocating over the past several years. We have still found no reason to step up potash to the levels recommended by the Ceylon Institute and our comments on on the "New TRI 700 series" were published in the Planters' Chronicle of January 1, 1962 and it is needless to elaborate on them again here.

The field trial started last year with a view to compare the efficiencies of various nitrogenous fertilisers was continued during the year, but no significant differences in yield have so far come to light.

Two small *ad-hoc* trials were carried out in the laboratory. The first concerned the storage of calcium ammonium nitrate, and the second involved the estimation of rate of mineralisation of urea. In the case of calcium ammonium nitrate, it was obvious that unless the fertiliser is packed in polythene lined bags, considerable losses of nutrient occur during storage. Full details of this trial with the figures of analysis carried out periodically are given in the Soil Chemist's report.

As regards the second trial, it was observed that almost the entire nitrogen contained in urea was converted to nitrate in the course of 6 weeks, whereas only half the quantity of nitrogen contained in sulphate of ammonia was so converted during the same period. This finding is of significance and value in circumstances where quick response to fertiliser application is desired.

Tea Prunings : Interest in this commodity was evinced by the Kerala Government as a source of raw material for the manufacture of caffeine at the Phytochemicals plant to be established at Neriamangalam. The removal of tea prunings from the field entails not only the loss of major plant foods contained in

the prunings, which can easily be made good by the supply of artificial fertilisers, but also considerable quantities of organic matter to replace which alternative green material should be specially grown in areas outside the tea for being incorporated into the tea soils. To do so, it was roughly estimated that one acre of spare land would be required for every 20 acres of tea which in most estates is not available. Further, in order to be able to supply only the top 6" of pruning which is required for caffeine extraction, an initial skiff before the actual pruning would be needed and this naturally involves extra labour which is not available on the estates and if specially recruited would pose a serious housing problem. On these considerations, the Association was not in favour of estates supplying the tea prunings.

Blister Blight: Screening of new formulations of fungicide was continued during the year and 13 organic fungicides and two based on copper were tested in 3 series of field experiments carried out both in the South-West monsoon and in the North-East monsoon. While satisfactory control was achieved with some, none proved outstandingly superior to copper.

Further trials carried out with nickel chloride have confirmed the earlier findings and it now remains to go into the question of economics of nickel spraying *vis-a-vis* copper spraying and examine the possibilities of commercial production of nickel fungicide.

Preliminary observations on the use of data of sunshine hours for adjusting spray timings were indicated in last year's report. Sunshine records were maintained throughout the 1961 Blister Blight season and studies made on the subject have proved beyond doubt that under the climatic conditions obtaining in most parts of South India, the record of sunshine hours is of little practical value.

Root Diseases: Several instances of root diseases were reported during the year and as mentioned by the Plant Pathologist, the incidence of root diseases is probably far more widespread than is at present realised. Removal of infected root materials from the soil and isolation of diseased patches by trenching have remained the accepted practices for many years, but they are obviously of only limited value. Field trials have been laid out with Vapam, a soil fumigant which was found promising in preliminary tests, but it is too early to reach any definite conclusions from these trials.

Clonal Selection and Multiplication: This work received almost the full-time attention of the Botanist throughout the year. The progress made in this work is fully reported by the Botanist in a separate paper included in the Appendix. It may only be mentioned here that out of a large number of selections made after stringent tests for yield and periodic check up on cup characters, at least ten clones can be considered as highly promising.

It is interesting to refer in this connection to an observation made by the Botanist on the occurrence of zinc deficiency in a V. P. nursery noted for the first time on tea in South India and corrected by the application of zinc sulphate spray.

Weed-Killers: Trials with various weed-killers appearing on the market has been one of the functions of the Botanist and the results of a few trials carried out are given in his report. While the use of dalapon for the control of grass seems admittedly an economic proposition, the same cannot be said with regard to control of other weeds by chemicals as, at present costs of weed-killers, hand weeding is still probably the cheaper.

Pests: The situation with regard to mite damage to tea has remained practically unchanged. Field trials were carried out with various acaricides, the results of which are incorporated in an article by the Entomologist appearing in the Appendix. An unconfirmed report has been received that Tedion V-18, which is an effective acaricide against tea mites, has received clearance from the United States Food and Drug Administration. Should it be confirmed, it could be used with safety on tea.

A severe attack of *Helopeltis*, which has generally been kept under control during the past several years, was reported from South Kerala. This once again raised the suspicion that the insect may have acquired resistance to DDT, but an on-the-spot examination made by the Entomologist revealed that this was not the case. DDT spray at recommended dilution and proper timing of applications brought the pest under control.

ACKNOWLEDGMENTS

The planting industry and other organisations connected with planting have always been of great assistance to the Scientific Department. I have great pleasure in acknowledging their assistance, as also that of Agents and Managers of estates who have kindly permitted us to carry out experiments on their estates.

Grateful acknowledgments are also made to the Chairman and members of the Tea Product Sub-Committee for their cooperation and guidance and to the UPASI Secretariat for the ready assistance received throughout the year.

Before concluding, it is a great pleasure to me and to my colleagues in the Department to convey our thanks to the Managers of the Estates visited during the year for hospitality received.

S. ANANDA RAU
Chief Scientific Officer.

[illegible]

REPORT OF THE SOIL CHEMIST

(1961—1962)

Advisory and Research :

The details of analyses carried out during the year in connection with advisory and research work are given in the following table:-

TABLE 1

Soils	...	...	602
Manures and Manure Mixtures		...	56
Compost	...	...	1
Cattle manure	...	...	1
Fish and Sheep manures	...	...	2
Tannery refuse	...	...	1
Sinews and hides	...	...	1
Insecticides and fungicides		...	11
Made tea—moisture	...	...	15
Made tea—nickel	...	...	21
Tea leaves	...	...	8
Grevillea leaves	...	...	2
Guatemala Grass	...	...	2
<i>Tephrosia vogelii</i>	...	...	18
Calcium ammonium nitrate	...	...	10
Dolomite	...	...	1
Total number of estimations		...	1833

The number of estimations exceeded that of any of the previous years. Consequent to the appointment of an Assistant Soil Chemist, in the beginning of April 1961, it was possible not only to attend to routine work quickly but also to undertake small items of *ad hoc* research.

Touring :

The following visits were made during the year:

1961	June	—	Glenvans & Devon Estates.
„	September	—	Messrs. Tata Fison's Laboratory, Bangalore.
„	„	—	UPASI Conference & Exhibition, Coonoor.
„	October	—	Farm Tea Estates, Kotagiri.
„	November	—	Glenmorgan & Devon Estates.
„	December	—	Glenmorgan & Terrace Estates.
1962	January	—	Touramulla Estate.

During the UPASI Exhibition, the texture of soils from the different tea growing areas in S. India was exhibited.

Publication :

A paper on "Discussions on Manuring of Tea" was presented during the Eighth Annual Conference. For inclusion in the "Notes on Current Problems" appearing in the Planters' Chronicle, the following articles were contributed: (I) Nitrogenous Fertilisers for Tea, (II) Tea Soils of South India, (III) A Note on the New T. 700 Series 1961, and (IV) A Note on Storage Trial with Calcium Ammonium Nitrate.

Blister Blight And Weedicide Trials :

A weedicide trial involving the use of Simazine and Tafapon individually and in combination was started on Touramulla Estate. The effect of these weedicides in the control of soft weeds and grass will be compared with the normal methods of weed control practised on estates. The weedicides will be applied in April and details will be given later.

As usual, cooperation was given to the Plant Pathologist in the conduct of the blister blight trials. Samples of manufactured tea from nickel sprayed plots were analysed for nickel residue.

Soils :

An unusually large number of soils was received during the year and most of them were from prospective nursery sites, both seedling and V. P. Many soils were accompanied by weed specimens for examination of root-knot eelworm infestation. The necessity for examination of soils and weeds for reaction and root-knot eelworm infestation has been stressed more than once in the previous reports. The problem of treatment of eelworm infested soils, both before and after planting is being investigated by the Plant Pathologist in detail.

Soils from mature tea areas and from supply or replanting sites were also analysed. In view of the large number of soils tested during the year, it was thought useful to examine the variations of pH values and organic matter contents of these samples. The pH determinations were carried out on air dry soils with quinhydrone electrode using a soil: water ratio of 1 : 2. The soils were shaken for two minutes and the suspension kept for about 20 minutes before adding quinhydrone and taking the reading. The organic carbon was determined by Walkley & Black's Rapid Titration Method and the figure multiplied by the factor 1.72 to get the organic matter figure.

From the determination of pH values of over 400 samples, it was found that nearly 35% of the soils are very strongly acid (4.6—5.0), 22% strongly acid (5.1 to 5.5) and 24% medium acid (5.6 to 6.0). Thus, over 80% of the soils tested lie between pH

4.60 and 6.00. Most of the extremely acid soils, i.e., pH below 4.5 were generally from high elevation estates. The slightly acid (6.1 to 6.5) to near neutral (6.6 to 7.3) soils were interspersed in many areas, mainly in Mysore and to a lesser extent in Nilgiri-Wynaad and Central Travancore. As regards organic matter content, analysis of over 200 samples indicated that 10% were poor, 30% fair, 25% very fair and 15% good. The soils rich to extremely rich in organic matter which represented 20% were from high elevation estates.

Six soil samples from the new Research Station in the Anamallais were analysed completely. The figures obtained are given in Table 2.

TABLE 2

		1	2	3	4	5	6
Moisture	%	6.7	6.3	6.1	6.9	7.7	3.3
Gravel & Stones	%	25.5	33.4	39.9	31.5	19.4	21.8
Coarse sand	%	30.4	35.2	35.9	29.4	27.1	53.0
Fine sand	%	17.4	14.5	14.9	17.5	12.2	10.9
Silt	%	25.3	21.7	18.8	24.8	25.7	14.3
Clay	%	26.0	29.1	32.4	28.2	35.4	21.7
Nitrogen	%	0.228	0.203	0.197	0.227	0.242	0.152
C/N ratio	%	11.3	9.8	9.5	10.4	9.4	9.4
Organic matter	%	4.4	3.4	3.2	4.1	3.9	2.5
Loss on ignition	%	18.0	16.6	14.2	17.9	17.7	10.2
pH		5.35	4.91	5.04	4.98	5.05	5.06
K ₂ O total	%	0.259	0.325	0.422	0.259	0.369	0.157
P ₂ O ₅ total	%	0.031	0.024	0.026	0.032	0.032	0.019
CaO total	%	0.11	0.07	0.11	0.11	0.11	0.11
MgO total	%	0.31	0.22	0.27	0.24	0.30	0.24
Fe ₂ O ₃ + Al ₂ O ₃	%	31.00	27.70	31.40	29.90	30.10	16.60
P ₂ O ₅ available (bulk)	%				0.0027		
K ₂ O available (bulk)	%				0.0245		

Mechanically, the soils are of clay loam type except No. 6, which is sandy clay loam in texture. The gravel and stones fraction is high as is generally the case with Anamallais soils. Chemically, organic matter is very fair to good in samples

1 to 5 and fair in sample 6. Nitrogen content is fair to good, total and available phosphoric acid are very poor, total and available potash are good and reaction very strongly acidic. As is common in tea soils, iron and alumina contents are high and calcium and magnesium oxides low.

A small trial was carried out to determine the rate of fixation of water soluble phosphoric acid by tea soils from the Nilgiri-Wynaad area. (1) To a fixed weight of soil increasing quantities of phos. acid in the form of water soluble phos. acid (Superphosphate) were added, thoroughly shaken and at the end of a fixed time, 24 hours, the amount of phosphoric acid remaining unabsorbed was determined colorimetrically. The results indicated that for a constant weight of soil and for a given period, the percentage of water soluble phosphoric acid fixed decreases with increasing quantities of acid. In another small trial, the variation in the fixation of phosphoric acid with respect to time was determined by estimating the phosphoric acid remaining unabsorbed after definite time intervals. It was found that the fixation increased with time for a given quantity of phosphoric acid and soil.

Manures and Manuring :

(a) *Analysis of Fertilisers:* Out of 49 fertiliser mixtures received for checking the guaranteed analysis, 7 failed to conform to the guarantee given by the suppliers. This is attributable to improper mixing and/or faulty sampling. One sample of fish manure was found to contain 64% sand. One sample of tannery refuse was analysed with the object of determining its fertilising value. The sample was found to contain 3.9% nitrogen, 0.3% phosphoric acid and 0.4% potash. The cost of the refuse was very high and the value of nitrogen was nearly four times that of nitrogen in sulphate of ammonia.

(b) *Mineralisation of sulphate of ammonia and urea in soil:* A preliminary trial was carried out to assess the extent of mineralisation of these two fertilisers under laboratory conditions. A known quantity of the salts to give 34.67 mg. nitrogen for 100 g. of soil was added in aqueous solution to the soil in beakers. Loss of moisture was made up every alternate day by adding the requisite amount of distilled water. The ammoniacal and nitrate nitrogen were determined at weekly intervals. The figures obtained are tabulated in Table 3.

TABLE 3

	Sulphate of Ammonia	Urea	
	Percentage conversion of original		
	Ammonium Nitrogen to Nitrate Nitrogen	Urea Nitrogen to Ammonium N.	Ammonium N to Nitrate Nitrogen
After 7 days	0	93.3	0
After 14 days	2.97	67.54	35.16
After 21 days	14.08	46.93	54.37
After 28 days	25.60	31.36	68.65
After 35 days	39.55	21.89	78.60
After 42 days	45.87	2.89	99.05

It appears that the rate of mineralisation of urea in the soil is more rapid than that of sulphate of ammonia. At the end of 6 weeks only about half the nitrogen in sulphate of ammonia was converted into nitrate, whereas nearly all the nitrogen in urea was converted into nitrate at the end of the same period.

(c) *Storage Trial with Calcium Ammonium Nitrate* : This trial was started in October and continued till February. The fertiliser and the bitumen lined hessian bag were supplied by the Kisan Khad Scheme of India. The fertiliser was stored in an ordinary hessian bag and in hessian bag lined with bitumen and alkathene. Moisture and nitrogen determinations – ammoniacal and nitrate – were made at monthly intervals. The details were published in the Planters' Chronicle. The results showed that the fertiliser stored in the ordinary bag absorbed moisture very quickly and five days after the start of the trial a concentrated solution of the soluble material began to drip from the bag. Consequently, the weight of the fertiliser decreased every month. The material remaining in the bag was wet and sticky and formed into hard lumps. Owing to the drip of the fertiliser from the bag the nitrogen content of the portion remaining in the bag fell by about 40%. It was very difficult to sample the material for analysis. None of these drawbacks occurred in the treated bag – there was no drip, the physical condition of the fertiliser remained excellent throughout, sampling was easy and nitrogen content remained constant. The following figures will be of interest :

TABLE 4

Weight of Fertiliser :

	Ordinary bag	Alkathene lined bag with bitumen layer
11-10-1961	58 lb.	58 lb.
11-11-1961	43 „	58 „
11-12-1961	40 „	58 „
11- 1-1962	36 „	58 „
11- 2-1962	33 „	58 „

TABLE 5

Moisture Content :

	Ordinary bag	Alkathene lined bag with bitumen layer
	%	%
11-10-1961	0.84	0.84
11-11-1961	4.34	1.24
11-12-1961	5.98	1.46
11- 1-1962	5.60	1.48
11- 2-1962	5.50	1.50

TABLE 6

Nitrogen Content :

	Ordinary bag		Alkathene lined bag with layer of bitumen	
	Ammonia nitrogen	Nitrate nitrogen	Ammonia nitrogen	Nitrate nitrogen
	%	%	%	%
11-10-1961	10.06	10.22	10.06	10.22
11-11-1961	6.28	6.28	10.06	10.06
11-12-1961	6.12	6.12	10.09	9.92
11- 1-1962	6.53	6.53	10.25	10.25
11- 2-1961	6.12	5.62	10.09	10.42

(d) *Effect of phosphatic fertilisers on legumes :* That phosphatic fertilisers exert a very marked beneficial effect on the growth of leguminous crops has been known quite well. The efficiency of different fertilisers depends on many factors such as the nature of the soil, method of application, the ability of the crop to utilise the plant food, etc. In a small scale field trial it was found that both rock phosphate and superphosphate increased the height, weight, phosphoric acid content of the shoots and roots and nodule formation in *Tephrosia vogelii* very markedly over the untreated controls at the end of a short period of 55 days. Superphosphate was found superior to rock phosphate in all respects at the end of this period. Owing to unavoidable circumstances the trial could not be carried till the plants flowered in order to assess the effect of the two rates and methods of application of the fertilisers. The figures obtained are given in Table 7 :

TABLE 7

Effect of Phosphatic Manures on *Tephrosia vogelii* at the end of 55 days.

	Ht. in cm. per plant	Wt. of fresh roots (g.)	Wt. of dried roots (g.)	Wt. of fresh shoots (g.)	Wt. of dried shoots (g.)	P ₂ O ₅ in mg. per plant	
						Roots	Shoots
Control	12.7	1.04	0.125	5.87	0.97	0.55	4.6
Rockphosphate 40 lb. placed	13.7	1.31	0.179	6.81	1.25	1.32	9.1
Rockphosphate 40 lb. broadcast	13.5	1.23	0.155	6.24	1.13	0.81	7.7
Rockphosphate 80 lb. placed	14.2	1.28	0.173	7.02	1.29	0.83	11.0
Rockphosphate 80 lb. broadcast	11.9	1.18	0.154	5.78	1.03	0.86	8.5
Superphosphate 40 lb. placed	16.8	1.71	0.235	10.31	1.78	1.40	12.1
Superphosphate 40 lb. broadcast	15.8	1.64	0.235	9.25	1.60	1.40	11.0
Superphosphate 80 lb. placed	16.3	1.61	0.228	9.71	1.66	1.60	13.6
Superphosphate 80 lb. broadcast	15.8	1.59	0.231	9.47	1.70	1.50	13.3

	Nodulation score	Nodule size
Control	0.98	Very small
Rockphosphate 40 lb. placed	1.25	Medium-large
Rockphosphate 40 lb. broadcast	1.15	Medium-large
Rockphosphate 80 lb. placed	1.27	Medium-large
Rockphosphate 80 lb. broadcast	1.10	Large
Superphosphate 40 lb. placed	1.97	Large
Superphosphate 40 lb. broadcast	1.70	Large
Superphosphate 80 lb. placed	1.58	Large
Superphosphate 80 lb. broadcast	1.66	Large

(e) *General*: The problems requiring investigation in manuring of tea have been discussed in the paper read during the Scientific Conference of the Department held in September 1961. There seems to be a general tendency on the part of many estates to follow the Ceylon recommendations on composition of mixtures and to apply very large quantities of potash to tea. Since potash deficiency has been noticed in Ceylon, increased amounts of this plant food are being recommended there. Whether the same holds good for S. India is doubtful in view of the fact that so far we have not come across instances of widespread potash deficiency here.

Fungicides and Insecticides :

The suspensibility of the wettable copper fungicides tested was found satisfactory but the suspensibility of two 50% DDT wettable formulations was not upto I. S. I. specification. In one it was extremely poor and in another, poor. Help was given to a proprietary firm in the spraying of tea with a miticide and in the preparation of sun dried and manufactured samples from the treated area for residue analysis.

Field Trials :

The manurial trial on Mayfield Estate to test different nitrogenous sources was continued. The application of fertiliser mixtures was made on 2nd May 1961 and 16th October 1961. The yield figures are given below in Table 8.

TABLE 8

Yield in kg./hectare (1-4-1961 to 31-3-1962)			
1.	Ammonium sulphate	...	2384.9
2.	Ammonium sulphate nitrate	...	2574.4
3.	Calcium ammonium nitrate	...	2346.2
4.	Chilean nitrate	...	2369.8
5.	Urea	...	2395.0
6.	Estate mixture	...	2424.2

The differences are only very slight and are not significant.

Acknowledgements :

Thanks are due to Managers of Estates visited for hospitality received. The Superintendent, Mayfield Estate, continued his cooperation in the conduct of the manurial trial; this is greatly appreciated. Most of the analytical work during the year was carried out by the Assistant Soil Chemist.

This is my last report and I take this opportunity to express my deep appreciation of the cooperation given by all members of the Scientific Department - past and present - in my work for 27 years.

V. JAYARAMAN,
Soil Chemist.

REPORT OF THE BOTANIST

(1961—1962)

General :

Consequent to the decision taken to intensify research on tea selection, the headquarters of the Botanist were shifted from Davarshola to Coonoor and the Botanist moved in there in the middle of April 1961. His laboratory and residence were temporarily situated in a rented cottage on Quail Hill until the middle of February 1962 when they were shifted to Brooklands Estate where a bungalow was made available for our use through the kind courtesy of Messrs. Kothari and Sons. The propagation nursery was situated at Brooklands Estate throughout the year.

Dr. K. S. Venkataramani, the Botanist, was elected a Fellow of the Linnean Society of London during the year. He was also appointed by the University of Madras as an examiner for the B.Sc and Ph.D degrees in the Faculty of Agriculture of that University.

At the request of the Coonoor Fruit Show Committee, Dr. Venkataramani served as a judge at the Fruit Show held at Coonoor in May 1961.

Advisory :

The advisory work attended to by the Botanist mainly concerned such subjects as tea selection, vegetative propagation, weed control and identification of plants. In addition to these, local enquiries on pests and diseases and cultural aspects of tea were dealt with by him. 118 soil samples were tested for their pH values and suitability for tea nurseries.

The total number of letters received by the Botanist was 264, and 366 letters were written by him during the year.

Visits :

Several visits were made to Brooklands Estate where the selection work was first mainly concentrated. In addition, the following estates were visited : Ben Gorm, Bowerlands, Colacumbie, Corsley, Craigmore, Curzon, Glendale, Havukal, Singara and Sutton.

While in Assam in December 1961, the Botanist visited five tea gardens, namely, Kakajan, Panitola, Cinnamara, Borspari and Numalighur where work on vegetative propagation has been in progress for some years. In all these estates considerable headway has been made on selection and propagation and the planters there were talking in terms of large scale clonal planting in the future years. He understood that there were about 1000 acres under clonal tea in North East India, although no one could let him have precise information on the acreage under clonal tea. It was most interesting to see a huge nursery which was being started at Panitola (the total length of the beds was said to run to some four miles). Every

aspect of vegetative propagation, from taking cuttings from the mother bushes to transplanting rooted plants in the field, has been standardised in most of these estates and the organisation of this work was very impressive. Large scale propagation as practised in some of these estates had initially cost considerable amounts, but it was the considered opinion of all the planters there that vegetatively propagated plants would eventually cost no more than the seedling plants. The Tocklai release clones were seen used for comparison purposes, although every endeavour was made by the estates to select their own clones equalling the best Tocklai clones or even surpassing them.

In connection with university examinations, Dr. Venkataramani visited the Post-graduate School of the Agricultural Research Institute at Coimbatore twice during the year. He also attended two lectures on chemical weedkillers delivered by Dr. B. Appala Naidu, Principal of the Andhra Agricultural College.

Publications :

The following papers were written by the Botanist :

- i. Hosts of the root parasite *Aeginetia indica*. *Current Science*, 30 (1961), p. 319.
- ii. Some factors concerned in rooting of tea cuttings (Presented at the Second Session of the Academy of Agricultural Sciences held at Coimbatore in December 1961).
- iii. Tea Selection. *Planters' Chronicle*, 56 (1961), p. 438.
- iv. The impact of science on tea culture. *Tea Trade and Industry*, 10, No. 8 (1961), pp. 27-34 (with Mr. S. Ananda Rau).
- v. Comments on the article "A Way with Weeds". *Planters' Chronicle*, 56 (1961) p. 5.
- vi. Root-knot eelworm population in a tea soil as influenced by the presence of a susceptible host plant. *Current Science*, 31 (1962), pp. 159-60.
- vii. Shade for tea in relation to environment. *UPASI Tea Scientific Department Bulletin* 20 (1961), pp. 6-21.

The following papers are included in the appendix to this Annual Report :

- i. Growth of tea cuttings under coloured polythene.
- ii. Effect of grass on the growth of young tea plants.
- iii. Rooting of tea cuttings as influenced by treatment with boron and indolebutyric acid.
- iv. First Progress Report on Tea Selection

Tocklai Conference :

This Conference was held on the 12th, 13th and 14th December 1961 at Tocklai and eleven papers were presented. The main themes of the Conference were the use of shade trees in tea and replanting and treatment of young tea.

On the subject of shade, three papers were presented. Dr. D. N. Barua concluded, in his paper entitled "Physical effects of shade and shade trees", that all cultural operations of tea are interlinked and governed by the climate and environment of a place, which also influence the selection of the right kind of tea for planting and that there cannot be a universally applicable policy for planting shade trees. The investigations described by Dr. W. Wight in his paper "Shade, manuring and kind of tea", demonstrate, in general, three important features of *jat* populations, namely, (a) the possible level of yield is genetically determined, (b) the yield under shade is related to the yield that can be obtained from fertiliser (N) without shade, and (c) the interaction of shade and N, which determines the economics of manuring is related to the anatomy of the petiole (vascular bundle index). Mr. S. K. Dutta's paper on "Efficient use of shade trees" dealt with the general principles of shade and shade tree management. The efficiencies of various shade tree species were mentioned and *Albizzia chinensis* (here still known as *Albizzia stipulata*) and *Albizzia odoratissima* were reported to be superior to the other species under trial as shade trees for tea. These three papers on shade stressed the importance of shade trees for tea in North-East India and showed how shade could influence the growth of tea bushes. As I have already discussed in my paper, "Shade for tea in relation to environment", presented at our Eighth Annual Scientific Conference in September 1961, most of our tea would benefit by regulated shade and we should look upon shade trees as a sort of 'insurance'.

With reference to the subject "Replanting and treatment of young tea" discussed on the second day of the Conference, Dr Wight stressed the importance of the kind of tea in relation to the environment. He also discussed the differences between a *jat* and a clone and added that we must learn how to deal with a clone growing on its own roots. To quote him: "With a clone, it is particularly necessary to even out soil differences as much as possible by the use of adequately balanced manures. And before doing that, it is necessary to ensure by proper trial, that the clone is suited to the place where we wish to grow it". It is hardly necessary to say that this is important for us too in South India, especially now that keen interest is being evinced in vegetative propagation of tea.

Research :

A. *Nursery problems* : During the course of advisory visits to estates two important nursery problems were encountered with, namely, (i) root-knot eelworm and (ii) 'bitten off' of tea seedlings.

Preliminary trials were undertaken to determine whether nematocide treatment of the soils supporting mildly infested tea plants would help in checking further infestation. For this purpose the soil in the baskets were treated with diazinon granules. The results were disappointing.

Tea seedlings showing early symptoms of 'bitten off' were treated with aluminium sulphate, the soil being drenched with 0.5% solution of aluminium sulphate. This treatment altered the soil reaction from the near neutral condition (pH value 6.8) to the acid side (pH 5.8 to 6.2) and resulted in arresting the development of the typical symptom of 'bitten off'.

B. Root-knot eelworm:

(i) The Botanist cooperated with the Development Pathologist of Messrs. Tata-Fison Limited in laying out two experiments on the control of root-knot eelworm. In the first experiment two organic nematocides were compared at two rates of application. In the second experiment, soil application of EDB granules was tested. Infested soil was used for preparing the experimental beds and two susceptible host plants, *Tephrosia vogelii* and *Lupinus angustifolius*, were employed as test plants, seeds being sown three weeks after treatment. One of the two organic formulations tested in the first experiment appeared promising. EDB granules also were effective in checking eelworm infestation to a great extent. All the three formulations also suppressed the development of root nodules. Further comment on these trials is not made, as it is felt that a repeat experiment is desirable.

(ii) A new organic nematocide, V-C 13 Nemacide, a product of Virginia-Carolina Chemical Corporation of the U.S.A. and supplied to us for trial by Messrs. Bharat Pulverising Mills Private Ltd., Madras was tested for its efficacy in an infested nursery. This product appeared to be very promising when applied as a soil drench at the rate of 1 lb. of V-C 13 Nemacide in 20 gallons of water applied over an area of 200 sq. ft. *Tephrosia* seed sown one week after treatment germinated normally and the growth of the seedlings was satisfactory. Cuttings planted two weeks after the treatment of the rooting medium were not injured. Well rooted tea seedlings were not affected by soil application of this nematocide when applied at a dilution of 1 lb. of the formulation in 100 gallons of water, but it was not clear whether such a treatment would kill the nematode ensconced in the root tissue.

(iii) During the course of advisory work, examination of some unhealthy young tea plants and a few mature tea bushes showed root-knot eelworm infestation of the feeder root system, although the main lateral roots were free from eelworm attack. This feature was evident only in places where *Tephrosia vogelii* was sown in large numbers as green-manure plants, and tea roots growing adjacent to *Tephrosia* roots showed eelworm infestation clearly. This suggested that *Tephrosia vogelii*, susceptible to the root-knot eelworm, could actually act as a breeding ground for

the nematode and an investigation made in this connection proved that it was so. It was not desirable to grow such highly susceptible plants as *Tephrosia vogelii* as green manure crops in tea fields, especially wherever this nematode is suspected, as they lead to a significant build up of the nematode population. It is suggested that instead of *Tephrosia* species *Crotalaria* species (*Crotalaria anagyroides* or *Crotalaria agatiflora*), which are highly resistant to this parasitic nematode, may be grown, if necessary.

C. Shade and Mites: Preliminary observations of a purely subjective nature made on two tea fields indicated that damage due to Purple mite was considerably less in shaded areas than in fully exposed areas. It was, of course, realised that more critical observations involving the study of mite populations under standard conditions were necessary to give a definite opinion on this subject. The indications, however, were that shade might have a beneficial effect in alleviating the ill-effects of mite attacks. An intensive study of the subject by the Entomologist might give more precise information.

D. Dry and cold weather chlorosis, and mineral deficiencies: Chlorosis of the foliage was noticed markedly on some tea bushes in fully exposed areas and not under shade during the months of December, January and February. This was observed on four high elevation estates in the Nilgiris. A similar chlorosis was also noticed in Assam during a visit there in December 1961. This chlorosis was confused by some people with magnesium deficiency symptoms. Foliar treatment with magnesium sulphate did not result in a change in the leaf colour. This chlorosis, in our opinion, was due to bright sunlight and the cold weather. Breakdown of chlorophyll could take place under such conditions, especially at high elevations due to the action of the ultra-violet complement of the sunlight. This condition was prominently observed on some bushes. It is likely that some clones alone are easily prone to such a malaise.

Zinc deficiency: Evidence of zinc deficiency was noticed for the first time in the vegetative propagation nursery in January/February 1962 in eight-months-old plants of two clones, 'B-34, and 'DRB'. The symptoms were interveinal chlorosis, uneven development of the leaf blade (sickle-shaped leaf) and stunting of shoot growth resulting in bunching or clustering of the leaves. Two foliar applications of zinc sulphate (1% solution) resulted in an almost complete recovery. It may be of some interest to record here the occurrence of zinc deficiency in mature arabica coffee bushes in some coffee growing areas of South India ("Zinc deficiency in arabica coffee" by B. R. Ananth & N. G. Chokkanna, *World Crops*, 14 (1962), pp. 89-91).

E. Effect of gibberellin on growth of 'banji' shoots: A pilot trial was conducted to determine whether dormancy in a tea shoot could be broken by spraying the 'banji' shoots with gibberellin (gibberellic acid). The indications were that such

dormant shoots could be roused to activity by gibberellin treatment and that the length of the growing shoots could be increased, though without any appreciable increase in the number of leaves. A further trial is being carried out and the results will be reported at a later date.

F. Grass cover and growth of young tea plants: The experiment commenced in December 1960 with clonal plants was terminated in August 1961, when the plants were carefully removed from the soil and examined for root and shoot growth. The plants under clean cultivation were far superior to those grown under grass sod. Full details of this experiment are given in the paper "Effect of grass on the growth of young tea plants" appearing in the Appendix to this report.

G. Weedkillers: (1) The two weedkiller trials with dalapon for the control of grass weeds, one at Daverashola estate and the other at the Tea Experiment Station, were terminated by the end of the year 1961. The results of these trials are presented here.

Trial I at Daverashola Estate: This trial was designed to find out whether reduced application of Dowpon would be effective in controlling grass weeds. A uniform area was chosen in a pruned field and twelve plots, each of 200 bushes, were marked out in September 1960 when the pruned bushes had put on foliage. The experiment comprised the following treatments :

- (a) Control (slash weeded)
- (b) Dowpon: 2 applications, each at 5.35 kg./ha. in 673 l. of water,
- (c) Dowpon: 2 applications, 5.35 and 3.36 kg./ha. in 673 l. of water.

The experimental plots were plucked according to the estate practice from the 12th September 1960 upto the 19th December 1960 and this constituted the preliminary yields, which are given below.

Plots marked for treatments	Green leaf in kg. from 800 bushes (4 plots) for 14 plucking rounds
(a)	564.1
(b)	559.4
(c)	561.4

As the differences were not significant, the plots were taken to be of uniform productive capacity and the first weedkiller application was made on the 23rd December 1960. The second application was made in June 1961. Yield records were continued to be maintained and they were as follows :

Period	Green leaf in kg. per 800 bushes (4 plots) in		
	treatments (a)	(b)	(c)
Jan. to March 1961 (8 rounds)	308.6	349.1	340.0
Apr. to Jan. 1961 (10 „)	401.8	435.9	423.1
July to Sept. 1961 (11 „)	352.2	368.6	350.0
Oct. & Nov. 1961 (8 „)	367.7	416.8	362.2
Total (37 rounds)	1430.3	1570.4	1475.3

The yield of bushes in plots treated with two rounds of Dowpon, each at 5.35 kg./ha. appeared numerically better than that of plots treated with one round of Dowpon at 5.35 kg./ha. and the other round at 3.36 kg./ha., although none of the differences was statistically significant. Grass weeds were completely suppressed by both treatments. Young dadap and grevillea shade plants in the experimental area were not damaged, as no rain immediately followed the weedkiller application.

Trial II at the Tea Experiment Station: Twentyfive 50 bush plots were marked in a first year tea field and the experiment comprised the following treatments :

- (a) Control (slash weeded)
- (b) Hand-weeded to remove all grasses once at the start of the experiment
- (c) Tafapon applied at 5.35 kg./ha. in 561 l. of water, 2 applications
- (d) Tafapon applied at 5.35 kg. ha. in 1 appln. and 4.5 kg./ha. in the second application.
- (e) Tafapon applied at 3.35 kg./ha. and 3.36 kg./ha.

Preliminary yields were recorded from the experimental plots for 23 rounds of plucking and they were as follows ;

Plots marked for treatments	Green leaf in kg. from 250 bushes (5 plots) for 23 rounds
(a)	171.8
(b)	175.5
(c)	185.0
(d)	160.9
(e)	187.3

The differences were not statistically significant and, therefore, the five blocks and the experimental plots were considered to be of uniform yielding capacity. The first application of the weedkiller was made on the 26th November 1960 to all plots receiving weedkiller applications. Five plots were hand-weeded, digging out all grasses without injuring the tea roots as far as possible and these plots did not receive any weedkiller application at any time. Five others were only slash weeded and left as controls. The second weedkiller application was made in June 1961 and the experiment was terminated by the middle of October 1961. The yields from the experimental plots were as follows :

Period		Green leaf in kg. per 250 bushes (5 plots) in treatments				
		(a)	(b)	(c)	(d)	(e)
Dec. 1960 to Mar. 1961	(13 rounds)	80.9	75.5	75.5	75.5	76.3
April to June	1961 (6 rounds)	153.6	152.2	157.7	143.6	157.7
July to October	1961 (8 rounds)	131.8	147.7	154.1	141.3	155.5
Total	(27 rounds)	366.3	375.4	387.3	360.4	389.5

Heavy rain followed the first application and there was no doubt leaching of the weedkiller into the soil. Although growth of grass was checked and the tea bushes did not exhibit any phytotoxic symptoms, the 'dadap' trees in the experimental plots were adversely affected. Shedding of 'dadap' foliage was first noticed in January 1961, nearly two months after the first application of the weedkiller. The trees, however, were not killed and refoliation was noticed in some of them early in March 1961. The slightly lower yields, not statistically significant, in all the treated plots as compared with those of the control plots may be due to insipient injury caused to the root system of the tea bushes by hand digging as well as by leaching of the weedkiller into the soil. In the final analysis, the difference between the treatments is not significant, although some of the treatments have yielded numerically slightly more than the control. Towards the end of the experimental period, namely, July to October 1961, the yields from all the treated plots were numerically more than that from the control plots.

(2) *Weedkiller trial at Singara Estate* : A fresh trial was undertaken at Singara Estate during the year under review to assess the value of Simazine, Atraton, Prometone, Prometryne, Cornox D, Kuron and Paraquat in controlling broad-leaf as well as grass weeds in tea fields. The experimental design consisted of a randomized block layout, each plot consisting of 100 bushes and each treatment being replicated four times. Yield records were maintained for six weeks prior to the first application of weedkillers and this constituted the preliminary yields. Only one application

of the weedkillers was given during the year early in February 1962, and until the end of March 1962 all the treated plots were comparatively free of weeds, both dicot and monocot, as compared with the untreated control. Paraquat appeared to give better control of all weeds than the other weedkillers. This observation, however, was based purely on a subjective estimate of weed density in the experimental plots. It is premature to comment further on this trial. The trial is being continued and the results will be reviewed at a later date.

(3) *Laboratory investigations*: Laboratory trials were made with Paraquat and Atraton employing the weeds *Ageratum conyzoides*, *Bidens pilosa*, *Blainvillea rhomboidea* and *Drymaria cordata* as test plants. All these weeds were susceptible to both weedkillers. Paraquat was extremely effective even at such a low dosage as 0.55 kg. per hectare. Treatments in which the sprayed foliage was washed with water 10 minutes after the weedkiller application with a view to wash out any of the weedkiller that might remain on the foliage showed that a 10 minute dry period interval was sufficient for the weedkiller to exert its effect and that rainfall after that short period may not materially affect the efficacy of the weedkiller. Atraton at 2 kg. per hectare was also effective in killing these weeds.

H. Vegetative Propagation:

(i) *Coloured polythene cover*: Polythene film of four colours, viz., transparent (natural or colourless), yellow transparent, red transparent and green transparent, were used to cover the tea cuttings and examination of the cuttings at the end of seven months showed that the cuttings under yellow polythene cover were the best from the point of view of shoot growth. The growth of the roots was not affected by any of these colours. Details of this experiments are given in an article appearing in the Appendix.

(ii) *Growth substances*: The role of Seradix B-2 powder, Planofix and Phymone in assisting root growth of tea cuttings was studied. As in earlier investigations, Seradix B-2 powder proved itself useful for rooting tea cuttings. Planofix and Phymone, when applied to the mother-leaf, did assist in the retention of the mother-leaf for prolonged periods and also induced early callus formation and root initiation.

(iii) *Trace elements*: Application of salts of boron, manganese, molybdenum, nickel and zinc to the rooting medium (drenching with a 100 p.p.m. solution) and spraying the mother-leaf with dilute solutions of these salts (50 p.p.m.) did not in any way influence the rooting of cuttings of three tea clones. Dipping the basal end of the cuttings in dilute aqueous solutions of the salts (50 p.p.m.) for 16 hours was neither beneficial nor harmful, except in the case of boron which was phytotoxic to some extent. A second trial was undertaken with boron in combination with indolebutyric acid (IBA) and the results are discussed in the paper "Rooting of tea cuttings as influenced by treatment with boron and indolebutyric acid" presented in the

Appendix. The findings, in brief, were as follows: IBA alone (100 p.p.m.) promoted good growth of roots. Boron by itself did not show any beneficial effect on root formation. Even with combination of IBA, boron did not prove useful. Above 20 p.p.m., boron suppressed root growth even with IBA, although the rooting was better than in the untreated control. This may be due to the effect of IBA and it is likely that IBA has to some extent counteracted the ill-effect of boron.

(iv) *Pretreatment of cuttings with nutrients and growth regulators*: A tea clone, selected for high quality, proved to be an extremely shy rooter. Various methods were tried to get a high percentage of strike, but in vain. Therefore, a series of experiments was started to determine whether pretreatment of the propagation material with nutrients and growth regulators, both singly and in combination, would aid in rooting such treated cuttings. The experiments are still in the initial stages and they will be commented upon in a later report.

(v) *Routine propagation*: Cuttings were taken, as and when available, from the bushes selected on Brooklands Estate and were put out for rooting in Brooklands nursery. During the year, over 25,000 cuttings were put out for rooting and about 6000 rooted cuttings were transplanted into polythene bags.

Mention must be made here of the several queries we have had from estates regarding failure of cuttings to strike. In some instances, the rooting medium was at fault, and in some others the adjustment of light intensity was improper. The rooting medium should be acidic in reaction, the pH value being round about 5; the medium should also be a sandy loam permitting good drainage of water, especially during the rains. Light should not be cut out completely; but at the same time, under estate practice, full light intensity is harmful. In our experience, we have found that at high elevations on the Nilgiris, shading the beds with a quarter inch mesh coir-matting is most suitable. Polythene covers could be usefully employed to cover the cuttings, but still an overhead shade is absolutely necessary. When polythene bags are used for transplanting rooted cuttings, it is necessary to see that at no time the soil gets water-logged. For this purpose, it is desirable to have a number of holes punched in the bags, preferably right up to the top.

I. *Tea Selection*: Work on tea selection at high elevations on the Nilgiris was commenced towards the end of April 1961 by the UPASI Tea Scientific Department. To begin with, selection was confined to tea fields in Brooklands Estate and later extended to those on Singara Estate, for the only reason that these estates were close to Coonoor and easily accessible to the Botanist. Towards the end of the year under review, selection was commenced in Curzon Estate near Kotagiri, as transport facilities for the Botanist was provided by the estate.

A number of enquiries on tea selection was attended to by the Botanist and he has had several personal discussions with the planters on this subject. Visits were made to a few estates in connection with tea selection and on the spot advice was given to them.

During the year under review, selection by the Botanist was confined to five fields in Brooklands Estate. He however, assisted Curzon and Singara Estates in the initial marking of promising bushes and cooperation of the managers of these estates was sought for recording of bush yields and miniature manufacture of clonal teas.

The number of bushes marked initially by eye-judgement was 372 on five fields on Brooklands Estate, 242 on a single field in Singara Estate and 59 in a field on Curzon Estate. Individual bush yield records were maintained for 12 rounds of plucking and in some cases the shoots harvested from the bushes were examined for the flushing behaviour. As reported earlier, there was some evidence of individual bushes being capable of flushing uniformly over a considerable period, but most of the bushes showed periods of rest and growth characteristic of the tea bush. Yields of the individual bushes were compared with the field yields during the period the selected bushes were under observation and those showing promise with respect to the yielding capacity were thus isolated. The bush yields, when examined on unit area basis, showed that most of the selections were capable of yielding 2.5 to 3 times the field yield and that only a limited number of bushes could be expected to produce crop more than thrice the field yield. The rooting capacity of cuttings from the selected bushes was also studied; except in a few selections, which were shy rooters, rooting was generally normal. Observations were also made for resistance to blister blight. None of the selections was immune to this leaf disease, but many of them showed a fair resistance. The selections which showed the highest promise for quality were the most susceptible to the disease.

Shoots harvested from the individual bushes were miniature manufactured employing a meat mincer and miniature dryer and such teas were made periodically and tasted and compared with high elevation teas. Over 200 clonal tea samples were made from bushes selected on Brooklands Estate and considerable time was spent on perfecting the technique of miniature manufacture.

It is premature to release any of these selections for large scale planting on estates. The indications, however, are that at least 10 promising selections are likely to result from this preliminary study. Further tests for quality, clonal planting and yield records are required for a proper appraisal of the performance of the clonal materials which have been initially selected as promising.

An account of the selections made is given in the article "First Progress Report on Tea Selection" appearing in the Appendix to this Annual Report.

J. *Plant Introduction*: Seeds of *Erythrina arborescens* Roxb., a species which thrives at high elevations up to about 2300 m. in Assam, were obtained through the kind courtesy of the Botanical Survey of India. The seeds germinated well and the growth of the seedlings in the nursery has been satisfactory so far. Should the future growth also be satisfactory, an attempt will be made to determine the usefulness of this species as a secondary shade tree in tea estates on the Nilgiris.

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The Botanist is grateful to the following for the assistance he has derived from them, and for the discussions he has had with them, in connection with tea selection: Messrs. Kothari & Sons, and Singara Nilgiri Plantations Co., Dr. W. Wight and Dr. D. N. Barua of Tocklai Experimental Station Assam, Mr. F. H. Kehl of the Tea Research Institute of Ceylon; Messrs. R. E. MacLaine Clarke, J. N. P. Beaver, V. A. Krishnan, R. Desai, and F. B. Chenoy of the Nilgiris; and Messrs. McNeill and Barbora of Assam. He is also deeply indebted to Messrs. Carritt Moran & Co., Cochin and the Planters Company, Coonoor, and in particular to Messrs R. Luff, D. E. H. Panter and T. N. Nair, for their willingness to taste and report on several experimental tea samples. The receipt of experimental samples of weedkillers and other material from a number of firms is also acknowledged with gratitude.

K. S. VENKATARAMANI

Botanist.

REPORT OF THE PLANT PATHOLOGIST

(1961—1962)

General :

During the absence of the Soil Chemist on leave in July 1961 I looked after the routine administration and field work in the Station.

The volume of technical correspondence increased considerably over that handled in the previous year.

Touring :

The following visits were made during the year :

May	1961	—	Daverashola Estate, Nilgiri-Wynaad; Goomankhan, Kelagur and Balehonnur Estates, Mysore State.
June	„	—	Glenvans, New Hope and Devon Estates, Nilgiri-Wynaad.
July	„	—	Daverashola Estate, Nilgiri-Wynaad.
August	„	—	Rousdon Mullai, Woodbriar and Mayfield Estates, Nilgiri-Wynaad.
September	„	—	Terrace Estate, Nilgiris.
October	„	—	Mayfield and Devon Estates, Nilgiri-Wynaad.
November	„	—	Devon Estate, Nilgiri-Wynaad, and Glenmorgan Estate, Nilgiris.
December	„	—	Rousdon Mullai and Woodbriar Estates, Nilgiri-Wynaad; Terrace and Glenmorgan Estates, Nilgiris.
February	1962	—	Daverashola and Mayfield Estates, Nilgiri-Wynaad; Chembra and Touramulla Estates, Malabar-Wynaad.
March	„	—	Sussex, Woodbriar and Mayfield Estates, Nilgiri-Wynaad.

I participated in the Eighth Annual Conference of the Scientific Department in Coonoor on September 12, 1961 and read a paper on blister blight.

On 7th and 8th October, 1961 I attended the UPASI Coffee Scientific Conference held in Bangalore, and under invitation from the Chairman, Mysore State Planters' Association, I read a paper entitled "The Economic Control of Diseases in Plantations". Full text of the paper has been published in *Planters' Chronicle*, vol. 56, No. 22, November 15, 1961, pp. 403-405.

In January 1962 I visited the Tea Research Institute of Ceylon. I was taken round several estates in the neighbourhood of Talawakele, to their sub-station in the mid country at Hantane and to the low-country sub-station at Kottawa. Meeting the heads of the sections of Chemistry, Entomology, Nematology, Plant Pathology and Plant Physiology, and the discussions I had with them on current research problems in their specialized fields were valuable experience. I was also much interested in the investigations being carried out by the Tea Research Institute of Ceylon on control of eelworm affecting mature tea, root disease eradication, virus diseases of tea, dadap and Guatemala grass and deficiency diseases in tea, dadap and Grevillea.

I visited Madras in February to attend a series of lectures and seminars held under the auspices of the University of Madras on the broad topic of "fungicides and plant disease control". The lectures were delivered by Dr. James G. Horsfall, Director, Connecticut Experiment Station, U. S. A., an eminent authority in the field of organic fungicides. I had opportunity to discuss with Dr. Horsfall our experiments with inorganic and organic fungicides in the control of blister blight.

Publications :

The following technical papers were prepared for publication during the year :

1. The relationship of interval and rate of application of nickel chloride and other inorganic and organic fungicides to the infection of tea plants by *Exobasidium vexans* Massee. A. R. UPASI sci. Dep. Tea Sect. for 1960-61: 51-61 (Jointly with V. Jayaraman).
2. The effect of interval between fungicide applications to tea plants on blister blight and yield. A. R. UPASI sci. Dep. Tea Sect. for 1960-61: 62-68.
3. Blister blight through a decade. UPASI Tea sci. Dep. Bull. 20 (1961): 38-53.
4. Powdery mildew on *Erythrina* (Accepted for publication in C.P. News).
5. Tea wax as a stimulant and fungistat of spore germination (Accepted for publication in Curr. Sci.)
6. Action of nickel salts on the blister blight fungus *in situ* (Communicated to *Phytopathology*).

(Appearing in the Appendix to this report)

7. A study of the comparative efficiency of nickel salts against blister blight disease of tea.
8. Application of copper and nickel fungicides with motorized mist blowers for blister blight control. I. Results of preliminary experiments.

9. Investigations on the usefulness of sunshine records in timing fungicide applications against blister blight.

In addition to the technical papers, a number of popular and advisory articles were published in *Planters' Chronicle*.

Advisory :

Seventy-five specimens of disease and past affected plants were received for examination during the year and reports on these sent.

Root disease control: It was stated in the last report that the root disease problem in tea estates was probably more serious than the picture given by enquiries received. We are now in a position to adduce proof to the situation being actually so, at least in certain areas which the writer had occasion to visit last year. The position is quite serious in certain estates in Mysore. Recently, a report was received from an estate in Malabar-Wynaad of more than seven hundred root disease patches in mature tea. During one of the visits to an estate, in a relatively small area of one field five *Poria* patches were detected. Obviously, the case sheet on root diseases is very long and their control deserves much more attention than what it is receiving.

At present the control measures recommended against tea root diseases are based on plant sanitation. Some diseases require simple treatment, as for example in the case of the 'Diplodia Root Disease' it is enough to uproot the affected plant(s), while in the case of others cleaning out the area of surface litter, and/or isolation by trenching are necessary. The area to be isolated also differs with different disease. Plants also die from causes other than root disease; isolation of such plants has been observed to result in wasteful expenditure. It is, therefore, essential that root diseases are recognized and at the outset of carrying out the control measures the particular disease in question is clearly identified. While this can be achieved by sending specimens of the diseased roots to the Scientific Department, it is gratuitous to mention that the estate management should be itself in a position to identify root diseases, more so in estates wherein the problem has attained a chronic form. It is doubtful whether even a very small fraction of any estate staff could identify the common root diseases. The solution to the problem would probably lie in individual estates organizing special gangs, charged with root disease control work, who could be instructed and trained,

Our experiments on chemical control of root diseases have not come to fruition yet. The trials are in the second year and it is hoped that results will be forthcoming soon to enable their inclusion in the next report.

Tree Killer: The removal of shade trees in mature tea is a critical operation connecting it with root disease control work. It is again emphasized that the best method for removal of shade trees is to ring-bark them and fell when they die.

The use of arsenite tree killers for bringing about the death of the plant, in as short a time as possible prior to felling, seems to be finding favour with certain tea planters. It has been our experience that stumps of trees killed by arsenite are attacked by *Fomes* and *Poria*, thus casting grave doubts on the use of such tree killers. It is suggested that the use of arsenite tree killers is eschewed till we are able to report on their effect on starch reserves in the roots of the treated plants. *Ad hoc* trials are now under way.

Reports have appeared from a tea research centre in Africa on the use of hormones for accelerating the process of depletion of carbohydrate reserves in roots of shade trees. This treatment aims at rendering the tree earmarked for felling safe against invasion by root disease fungi in a relatively shorter time than what is taken by ring-barking to achieve the same end. The recommendation for treating *Grevillea* is as follows: Either 2, 4-D or 2, 4, 5-T is applied as a solution in diesel oil in frills cut into the bark at the rate of 20 cc. per 2.5 cm. of girth of the tree. When using 2,4-D a 6% solution in diesel oil is applied only once, whereas 2,4, 5-T is suggested at 3% strength in two applications at a week's interval. April/May treatment gives best results. Trials have been undertaken at the Station to study the rate of starch depletion in roots of *Grevilleas* which are (i) ring barked, (ii) treated to hormone and (iii) treated to arsenite tree killer. Results will be reported shortly.

Diplodia Root Disease: This disease was noticed on several 3-year old tea plants in patches in a field which had been irrigated for 2 years, but irrigation stopped thereafter. Examination of dead bushes revealed a severe attack of *Botryodiplodia theobromae* on the main and lateral roots. The affected plants had produced a thick mass of surface roots, as a result of irrigation, and once when irrigation had been stopped the bushes were affected very adversely in drought. As experiments have shown that tea roots exposed to sun are extremely susceptible to the 'Diplodia Root Disease', it is very likely that bushes with surface rooting would be prone to the disease in drought.

Hypoxylon Stem Disease: During the year several instances have been noticed in Mysore and in Wynad of *Hypoxylon* stem disease. This disease has been reported once before from the High Ranges and Anamallais (A. R. UPASI sci. Dep. Tea Sect. for 1935-35: 28-29). A species of the same fungus causes a root disease known as 'Tarry Root Rot' in N. E. India. It has been previously stated, and now reiterated, that the *Hypoxylon* disease in S. India is a stem disease. Only the branches and the collar of tea bushes are attacked and in no case is the disease seen to affect the roots. The diseased plants look weak, gradually decline and die in course of time.

The disease is easily recognized from its fructifications which take the shape of irregular patches, greyblack in colour, slightly raised, more often measuring from 0.5 to 3 cm. in length and breadth, but sometimes exceeding 3 cm. and found either

at the collar or on any of the branches. The species of *Hypoxyton* causing the stem disease in S. India has been identified as *Hypoxyton serpens* (Pers ex Fr.) Kickx, whereas the causal agent of the "Tarry Root Rot" in N. E. India is *Hypoxyton asarcodes* (Theiss.) Miller.

Control measures against the disease follow the pattern recommended against 'branch canker'. Affected branches on which the fungal fructifications are noticed should be cut and burnt. When the collar is affected the plant may be collar pruned and the diseased plant tissue burnt. All the dead/dying branches should be pruned to healthy wood and the pruning cut painted with a fungicide. It has been noticed that even when the main stem is attacked by *Hypoxyton*, the plant roots often contain adequate starch reserves to enable the plant to stand a drastic collar prune; such plants throw out fresh shoots vigorously after the prune. The disease is classified as a slow wood rot, impairing functions of the stem but not affecting the roots. The important point to bear in mind while undertaking control measures, is that all the diseased tissue with the fungal fructification should be burnt to minimize chances of fresh infection which occurs when the fungal spores, disseminated by wind, are carried and lodged on fresh infection sites.

Die-back in pruned tea: During the year three reports were received, two from Wynaad and one from Mysore, of 'die back' in bushes recovering from pruning. Field investigations showed that the branches in the affected plants were badly sun-scorched, decay of the scorched tissue had progressed and in severe cases spread into the healthy tissue, sometimes girdling the entire branch. The stem functions were consequently impaired leading to die back of the shoots on the affected branches and in extreme cases the bushes had died. The root system of all the affected plants examined was rich in starch reserves. Neither *Botryodiplodia theobromae*, nor any other parasitic fungus was found in the roots. The failures were not caused by lack of carbohydrate reserves in the roots, on the other hand they were due to sun scorch damage, accentuated by removal of overhead shade. The damage was noticed only in fields pruned in late February or before the middle of March and was greater in fully exposed areas with Western facing than elsewhere. Though in an occasional good year one could get away with pruning in February/March, a study of the relative humidity data for these months over the past several years at the Station, has made it abundantly clear that periods of dangerously low relative humidity occur in these months, when pruning would certainly lead to serious sun scorch damage.

Sunshine records and blister blight: Results obtained in our investigation (reported in the Appendix) have not confirmed the reports from Ceylon and Indonesia of the usefulness of timing fungicide application based on sunshine hours in the control of blister blight. Disease control achieved with spraying on interrupted rounds, spraying being postponed when total sunshine in a certain period

prior to application reached a stipulated figure, was markedly less than in the regular rounds. It is doubtful whether the saving in cost of treatment by reducing the number of applications would offset the risk of crop losses and impairment to bush vigour resulting therefrom. Postponing fungicide application based on sunshine hours is not recommended for estates in the Wynaad and in areas where similar climatic conditions obtain. Fungicide treatment at intervals upto 10 days should be regularly carried out.

Eelworm: Instances of root-knot eelworm damage in tea nursery seemed to be quite high. In view of the fact that the cost of treating soil against the eelworm is small *vis-a-vis* the risk taken in using infected soil, it is recommended that the nursery beds, or when going in for basket nursery the soil which is used for filling the baskets, be treated with a fumigant. Heating the soil and formalin drench are effective but laborious. On the other hand, relatively simple methods of injecting chemical fumigants into the soil are suggested. Full details are reported in an article entitled 'Eelworm' in *Planters' Chronicle*, vol. 56, No. 23, December 1, 1961, p. 417.

Collar rot in clonal planting area: Reports of collar rot in young V. P. plants in new clearings continued to come in. In all cases the stem above the nursery level was girdled and obviously deep planting had predisposed the plants to the disease.

Shade Trees :

Eelworm affecting Grevillea seedlings: One lot of *Grevillea* seedlings was received with a report of poor growth in the nursery. Some of the seedlings were severely affected by the root-knot eelworm, and although *Grevillea robusta* is known to be susceptible to this eelworm, this is the first instance of its record here.

Diseases of dadap: During the year a powdery mildew caused by a species of *Oidium* was recorded on dadap (*Erythrina lithosperma*) seedlings in the nursery. The disease has, however, not been noticed in mature dadap.

A bacterial disease caused by a species of *Xanthomonas* was observed on both dadap seedlings in the nursery, as well as on mature plants in the field. The disease is characterized by numerous dark-brown specks, slightly raised, covering the interveinal region, but sometimes present on the veins also. A disease of *Erythrina indica* caused by *Xanthomonas erythrinae* has been reported from Bombay in 1952.

Another disease, which is yet of uncertain origin, was common in mature dadaps. In this the leaves develop irregular, large, chlorotic areas between the veins, giving it a blotched appearance. No deleterious effect on the diseased dadaps could, however, be noticed.

Grevilleas: A new leaf disease affecting *Grevillea robusta* has been recorded and will be reported shortly. Certain reports received from areas in the Wynaad stated that *Grevilleas* were looking thin and unhealthy during the heavy monsoon in July-August. From the affected specimens a species of *Dothiorella* has been consistently isolated and a separate note on this disease will appear shortly.

Miscellaneous :

Root-splitting disease of Hakea: A species of *Armillaria* was found on a lot of specimens of diseased *Hakea* roots sent from an estate in Tirunelveli District. Typical rhizomorphs of the fungus, but no fructifications, were seen. The affected roots had split, through which the red sheath of the fungal mycelium could be seen.

Research :

Blister blight experiments: A very heavy load of work was taken from June through December to carry out field and laboratory trials on various aspects of blister blight control. Fifteen new experimental formulations, thirteen organic and two copper, and three proven fungicides employed for comparison, were tested and some of the results are given below.

Experiment 1: This was started on June 15 and continued till September 6. The trial was laid out in a second year field with two rows each of 5 bushes comprising a plot, each treatment being replicated four times and the treatments randomized. Spraying was carried out at the rate of approximately 168 litres per hectare (15 gallons per acre), using pressure retaining knapsack sprayers fitted with T-jet nozzle. Fungicide application was made at 7-day intervals soon after harvesting all the pluckable shoots. A random sample of 100 shoots was picked from the entire lot harvested, examined individually and percentage infected shoots recorded. Average infection of the four plots in each treatment is given in Table I.

TABLE I

Average percentage shoot infection at weekly assessments in the fungicide sprayed and unsprayed plots in Experiment I

Fungicide	Rate per hectare	Percentage shoot infection on							
		12/7	19/7	26/7	2/8	9/8	16/8	23/8	30/8/61
Dithane M-22	420 g.	29.0	67.0	65.2	72.0	81.7	34.5	16.5	26.0
Dithane Z-78	420 g.	38.0	75.5	72.5	76.0	75.7	29.5	18.0	33.0
Cuproxol	420 g.	15.2	29.7	30.0	28.2	37.7	26.2	10.2	18.7
Bordo 77	420 g.	7.7	31.0	31.7	32.2	30.5	19.2	10.7	18.2
Bordo 77	210 g.	16.5	47.7	39.7	39.7	40.7	32.5	10.2	21.5
Bordo 77	105 g.	16.7	52.7	46.7	57.0	60.7	35.2	17.2	23.7
Kirticopper 40-W	420 g.	14.2	43.0	31.2	39.2	39.0	19.5	16.2	20.5
Bayer 4962	420 g.	60.5	87.7	69.2	—	—	—	—	—
Perenox	420 g.	12.2	28.5	32.5	33.2	32.2	17.5	8.0	16.0
Nickel chloride	420 g.	10.2	27.2	27.0	24.2	21.5	8.7	6.5	24.0
Control		75.7	99.0	90.2	96.5	92.2	67.0	49.0	65.2
Difference required for significance $P = 0.05$		10.9	15.8	11.5	13.5	11.2	11.8	9.8	9.6

Three organic formulations, viz., Dithane M-22 (Manganese ethylene bisdithiocarbamate, 70% WP), Dithane Z-78 (Zinc ethylene bisdithiocarbamate, 65% WP) and Bayer 4962 (Hexacyanoferrat), gave very poor protection at the concentration of 240 g./hectare (6 oz./acre). The four copper fungicides, namely Cuproxol (50% metallic copper as copper oxychloride), Bordo 77 (40% metallic copper as cupric hydroxide), Kirticopper 40-W (40% metallic copper as cuprous oxide and 10% organic fungicide based on curcumin) and Perenox applied at 420 g./hectare gave equal blister blight control throughout, differences being statistically insignificant. Bordo 77 is a new fungicide and it was interesting to observe that at 210 g./hectare (3 oz./acre), but not at 105 g. (1.5 oz.), it controlled blister blight to a fair extent. Disease incidence in nickel chloride treatment was lower than in the copper treatment at the same rate of fungicide application per acre.

Experiment 2. Eleven experimental formulations, all organic, were screened in another trial. This was laid out in a first year field with one row of nine bushes in a plot, replicated four times in a treatment and randomized. The fungicides were sprayed at the rate of approximately 168 litres per hectare (15 gallons per acre) with hand syringe fitted with Bray 000 nozzle. Examination of shoots to determine percentage infection was carried out as in Experiment 1.

TABLE II

Results of fungicide screening trial in Experiment 2

Test Fungicide	Rate of application as ppm. Active Ingredient.	Percentage disease recorded weeks after the first application.		
		3	4	5
E. F. 1	5,000	32.3	43.4	52.7
	7,500	56.0	50.0	40.4
E. F. 2	5,000	69.5	69.1	44.6
	7,500	65.2	65.5	33.4
E. F. 3	5,000	78.1	92.0	69.2
	7,500	73.3	69.1	46.4
E. F. 4	5,000	35.3	41.6	23.5
	7,500	16.3	18.1	7.1
E. F. 5	5,000	73.3	63.8	53.4
	7,500	78.1	98.8	79.7
E. F. 6	5,000	85.8	85.3	53.4
	7,500	80.4	80.0	79.7
E. F. 7	5,000	83.5	79.2	48.1
	7,500	55.7	70.7	33.4
E. F. 8	5,000	53.6	51.7	64.9
	7,500	60.7	85.3	90.2
E. F. 9	5,000	74.9	63.1	64.3
	7,500	89.6	81.0	88.5
E. F. 10	5,000	64.4	75.2	55.0
E. F. 11	5,000	52.5	52.8	35.8
	7,500	65.7	36.3	34.7

Results obtained (Table II) clearly showed that with the exception of Experimental Fungicide 4, none of the other test formulations gave satisfactory disease control. With E.F.4 at 7,500 ppm. active ingredient the results were extremely encouraging and this fungicide warrants further trials.

Nickel fungicides for blister blight control: In continuation of the previous year's work, Experiment III of the 1961 field trials was carried out to compare the efficiency of several nickel salts and nickel plus organic fungicides against blister blight. Results are incorporated in an article appearing in the Appendix of this issue.

Spray timing based on sunshine: As stated in the Annual Report for 1960-61, pages 36-37, the question of timing fungicide application based on sunshine records, with a view to cutting down the cost of protection, was thoroughly investigated. Results of two experiments carried out on this subject have been consolidated in a paper which appears in the Appendix.

Use of power operated mist blowers: A trial was laid down to investigate the efficiency of blister blight protection resulting from copper and nickel fungicides applied at ultra low volumes with a power operated knapsack mist blower. Results are given in the Appendix.

Summary of 1961 Blister Blight Trials: The results of the fungicide screening trials carried out in 1961-62 have been reported in the "Results of 1961 Fungicide-Nematocide Test" published by the American Phytopathological Society.

Resistance to blister blight: A number of clones resistant and immune to blister blight are being collected to study the breakdown pattern of these clones to the disease under variable environmental conditions and to study physiologic races of *Exobasidium vexans* Massée.

Eradication of blister blight: In addition to nickel fungicides which have been already reported to possess excellent eradivative action against *Exobasidium vexans*, certain organic fungicides have also exhibited eradivative properties against this fungus and these are being studied further.

Eradication of root disease: Our trials with Vapam for the eradication of root diseases were laid out in May 1961 but they have not run sufficiently long to permit of any conclusive results. The trials are being continued.

Diplodia Root Disease: Studies were made of the conditions under which *Botryodiplodia theobromae* attacks tea plants and results will appear shortly.

Control of Eelworm in mature Tea: This trial reported in the previous report was continued during 1961-62 but has not yet yielded any conclusive results.

Eelworm in tea nursery: A number of pot and field trials were undertaken to test various nematocides for the control of the root knot nematode, *Meloidogyne incognita*. *Tephrosia vogelii* and *Erythrina lithosperma* were employed as indicator plants to assess the efficiency of treatment with 1) American Cyanamid Experimental Nematocide 18, 133, (2) Diazinon, (3) Dowfume W-85, (4) Ethylene dibromide 45% granules, (5) Formalin, (6) Fumazone 70-E, (7) A 955, (8) A 963, (9) Nemacur, (10) Nemagon, (11) Telone, (12) Vapam and (13) VC-13. Experimental Nematocide 18,133 and VC-13 were tested as post-planting treatments while all others were applied three weeks prior to planting. A full report of the trials will be published shortly, but a short summary of the field experiments has appeared in "Results of 1961 Fungicide and Nematocide Tests" published by the American Phytopathological Society.

ACKNOWLEDGEMENTS

I thank the Director and Officers of the Tea Research Institute of Ceylon for the courtesies extended to me during my visit to the Institute, and the Director, Commonwealth Mycological Institute for identification of fungi. Thanks are due to Prof. T. S. Sadasivan, Director, University Botany Laboratory, Madras for making possible for me to attend Prof. Horsfall's lectures at Madras, and to Sri V. Jayaraman, Soil Chemist, for his help in carrying out some of the blister blight work. I also thank Managers of various estates visited by me during the year for their help and hospitality, and the various firms who have sent us free samples of fungicides and nematocides for experiment.

C. S. VENKATA RAM
Plant Pathologist

REPORT OF THE ENTOMOLOGIST

(1961—1962)

Through the courtesy of Messrs. A. V. Thomas & Co., Ltd., I continued to stay at Arnakal Estate, where I was provided accommodation and facilities for work.

Correspondence :

Letters received and despatched numbered 149 and 167 respectively. Majority of the enquiries related to Thrips, Mites and Shot-hole borer of tea.

Advisory :

Enquiries relating to insect and other pests were fairly numerous during the year, those relating to mites and thrips predominating. The year was exceptional in that damage by insect and mite pests was experienced on a bigger scale than in any previous year. Thrips, which is usually considered to be a minor pest of tea, assumed serious proportions and was the cause of considerable damage on several estates in Central Travancore and South Travancore. Red Spider and Purple Mite were on the increase and necessitated the adoption of control measures over larger areas. Scarlet Mite, the damage by which was hitherto considered negligible, was reported from several estates where its attack had resulted in considerable damage. There has been a tremendous build up of shot-hole borer population in several estates in Central Travancore.

Touring :

21 estates were visited in Central Travancore and 2 estates in South Travancore. Periodic visits were made to two estates in connection with field trials carried out there. I visited Coonoor in September, 1961 for attending the Eighth Annual Scientific Conference.

MITES

Red Spider: *Oligonychus coffeae*, (Nietn)

Purple Mite: *Calacarus carinatus*, Green

Scarlet Mite: *Brevipalpus australis*, Tucker

Attacks by these three species of mites continued to be reported from estates from all the tea districts and considerable time was devoted to work connected with screening of new acaricides for controlling them.

Screening Tests.

Field trials:

Five field trials were carried out for the screening of acaricides against mites. The following acaricides were tested during the year:

*Acaricides**Sources of supply.*

Akar	M/s	Tata-Fison Ltd., Bangalore
Mitex	,,	Bharat Pulverising Mills, Madras
Malathion	,,	-do- -do- -do-
Paramar	,,	-do- -do- -do-
Trithion	,,	Mysore Insecticides Company, Madras
Kelthane	,,	Amritlal & Co., Bombay
Ekatin	,,	Sandoz Products, Bombay
Sayphos	,,	I. C. I. Ltd., Madras
Rogor	,,	Tata-Fison Ltd., Bangalore
Eradex	,,	Bayer-Agrochem, Bombay
Metasystox	,,	-do- -do-
4974	,,	-do- -do-

The table which follows enumerates the acaricides tested, concentration used, mites against which the sprays were directed and brief remarks as to whether sprays were satisfactory or not.

<i>Acaricide</i>	<i>Concentration</i>	<i>Mite</i>	<i>Remarks</i>
Akar	1 in 1000	Purple Mite	Satisfactory. Ovicidal action fairly satisfactory
		Red Spider	Satisfactory
		Scarlet Mite	Satisfactory. Residual effect for only 10 days; needs repeating.
Ekatin	1 in 750	Red Spider	Initial effect satisfactory; limited ovicidal action.
		Purple Mite	Satisfactory
		Scarlet Mite	Unsatisfactory; limited systemic effect.
Eradex	1 in 1000	Red Spider	Initial kill satisfactory
		Purple Mite	Unsatisfactory
		Scarlet Mite	Unsatisfactory
Kelthane	1 in 1000	Red Spider	Satisfactory
		Purple Mite	Satisfactory
Malathion	1 in 1000	Red Spider	Satisfactory; very poor residual effect, good ovicidal action.
		Purple Mite	Fairly satisfactory
		Scarlet Mite	Satisfactory initially but residual effect poor.

<i>Acaricide</i>	<i>Concentration</i>	<i>Mite</i>	<i>Remarks</i>
Mitex	1 in 1000	Red Spider	Satisfactory
			Satisfactory
			Satisfactory; good ovicidal action.
Paramar	1 in 2000	Red Spider	Satisfactory
			No residual effect
		Purple Mite	Satisfactory
		Scarlet Mite	Satisfactory initially but very poor residual effect.
Metaystox (R)	1 in 1000	Red Spider	Satisfactory
		Purple Mite	-do-
		Scarlet Mite	-do-
			Eggs hatch but due to retention of toxicity the young ones die.
Rogor 20	1 in 1000	Red Spider	Satisfactory
		Purple Mite	-do-
		Scarlet Mite	Satisfactory; hatched eggs die due to systemic effect of insecticide.
Trithion	1 in 1000	Red Spider	Satisfactory
		Purple Mite	-do-
			good ovicidal action.
Sayphos	1 in 500	Red Spider	Satisfactory
		Purple Mite	-do-
		Scarlet Mite	Fairly satisfactory
			Limited ovicidal action.
4974	1 in 1000	Red Spider	Satisfactory
		Purple Mite	-do-
		Scarlet Mite	-do-
			Effective against eggs.

Laboratory trials: Screening of several acaricides were carried out in the laboratory. The object of these trials was to study the effect of these acaricides on eggs of Red Spider. Three trials were carried out. The results are given below:—

EXPERIMENT No. 1

<i>Treatment</i> (Dilution in parts of water)		<i>Percentage unhatched eggs</i> (mean of 5 replications)
Akar	1 in 1000	95.7
Ekatin	1 in 1000	51.0
Trithion	1 in 1000	92.9
Eradex	1 in 1000	73.5
Malathion	1 in 1000	93.5
Sayphos	1 in 500	67.2
Kelthane	1 in 1000	91.7
Mitex	1 in 1000	91.4
4974	1 in 1000	88.3
Check		2.6

EXPERIMENT No. II

<i>Treatment</i> (Dilution in parts of water)		<i>Percentage unhatched eggs</i> (mean of 2 replications)
Eradex	1 in 500	88.3
Eradex	1 in 1000	85.5
Mitex	1 in 500	96.2
Mitex	1 in 1000	85.1
Malathion	1 in 500	92.5
Malathion	1 in 1000	89.3
Akar	1 in 500	90.9
Akar	1 in 1000	81.1
Ekatin	1 in 1000	56.3
Ekatin	1 in 500	60.9
Check		0

EXPERIMENT No. III

<i>Treatment</i> (Dilution in parts of water)		<i>Percentage mortality of Red Spider eggs</i> (mean of 5 replications).
		97.2
Malathion	1 in 1000	98.9
Kelthane	1 in 1000	76.7
Akar	1 in 1000	37.4
Ekatin	1 in 500	3.7
Check		0

Malathion, Kelthane, Mitex and Trithion are highly effective against eggs of Red Spider. Akar, Eradex, 4974 also give satisfactory kill. Ekatin and Sayphos have poor ovicidal action.

THRIPS

Several reports of damage to young tea flush by thrips during the dry weather were received almost simultaneously from Central and South Travancore. In addition to loss of crop, the damage was stated to result in falling off in the quality of made tea and poor appearance as a result of excessive stalk and fibre. From the present indication thrips have to be reckoned as a potentially dangerous pest which the tea industry may have seriously to contend with in future years.

The study of life history and bionomics has been taken in hand. As regards control measures, several field trials were conducted with various formulations of insecticides.

The following insecticides were tried :

- Dieldrix 2 oz. in 10 gallons of water
- DDT 50 WP 1 lb in 20 gallons of water
- Folidol E 605 - 5 oz. in 100 gallons of water
- Malathion 50 EC - 8 oz. in 100 gallons water
- Basudin 20 - 8 oz. in 50 gallons water

All the formulations were applied at a rate of 50 gallons per acre. Three applications were made. Dieldrix, Folidol and Malathion were very effective. Basudin was satisfactory, and DDT did not give the same degree of control as the other formulations.

In a further trial the following insecticides were tried :—

- Rogor 20 — 12 oz. in 100 gallons
- Dipterex — 1 lb. in 100 gallons
- Sevin 50W — 1½ lb. in 100 gallons
- Folidol — 8 oz. in 100 gallons
- DDT — 1 lb. in 10 gallons
- Dieldrex — 2 oz. in 10 gallons

All these formulations were applied at a rate of 100 gallons per acre and three applications were made at intervals of 10 days. Rogor, Dipterex, Sevin, Folidol and Dieldrex were very effective. DDT, even at double the normal concentration, did not give control of the same order of efficiency.

Spraying with DDT was reported earlier to give good control. But it is difficult to explain now the failure of DDT to give satisfactory control. There were reports from several estates that they have experienced the same situation. Further critical studies will be made into this problem when opportunity arises. It is very essential that repeated application of any formulation of insecticide is to be made to get adequate control and that both upper and lower surfaces of the leaves are to be drenched thoroughly with the insecticide.

FLUSHWORM

This pest continues to cause damage in some estates in Central Travancore. Attempts were made to find out the utility of bacteria in controlling flushworm. Culture of a bacterium, with which useful results were reported in the control of other caterpillar pests, was obtained from a firm. The material used in the test was a sample of Thuricide. Infested shoots were collected from the fields and finely atomised spray of Thuricide was directed on to the infested shoots so as to get a uniform coverage of the spray. The results were not encouraging. It was apparent that the spray fluid did not reach the caterpillar enclosed in the leaf fold. Because of the mode of action of the organism, it is essential that the spores of the bacillus should be ingested by the caterpillar. It is proposed to repeat the spray in the field when weather conditions are favourable.

A few insecticide formulations were tested against flushworm, namely, DDT, Malathion, Basudin, Dipterex and Folidal. All of them gave fairly satisfactory control.

HELOPELTIS

No critical work on this pest was possible during the year. There was a report from one of the estates in South Travancore stating that, in spite of repeated application of DDT, *Helopeltis* was not under check. So an opportunity was taken to visit the estate to make a field study of the pest situation and also to investigate the possible cause of failure of DDT to control the pest. It was observed that the failure of DDT to control the pest was due to the faulty application of the insecticide with too low dosage at too long intervals. There was also suspicion about the quality of DDT used.

Trials conducted last year have shown that *Helopeltis* has not acquired resistance to DDT. The details of last year's trials are given below. The experiment was laid out in a field due for pruning. The experiment consisting of 36 plots each of 100 bushes was laid out on a randomised block design with four treatments including control and 9 replications of each treatment. Two rounds of spraying were done at an interval of 12 days. The number of attacked shoots in each plot was counted in one pound of green leaf collected at random from pluckable shoots. The yield data was also recorded. The results are given below :

Treatment	Infested shoots before spraying and yield		Infested shoots after spraying and yield					
	(8-12-60)	(20-12-60)	(6-1-61)	(17-1-61)	(28-1-61)	(10-12-61)		
(A) DDT 50 WP 1 lb. in 10 gall.	2802 12*	877 17*	644 77*	97 78*	27 86*	10 103*		
(B) Sevin 50 W 1½ lb. in 100 gall.	2527 11*	1487 12*	925 72*	353 80*	142 79*	64 96*		
(C) WL 1650 0.5 lb. per acre	2650 12*	1415 12*	869 59*	232 84*	131 81*	58 99*		
(D) Control	2732 13*	2642 11*	1196 56*	592 67*	334 63*	362 97*		

* denotes yield in lb.

The indications of this trial are that *Helopeltis* has not gained resistance to DDT, and that DDT is still superior to the other two insecticides.

SHOT HOLE BORER

Observations made during the year indicated that this pest is getting more widespread in Central Travancore. It is only at the time of pruning that the extent of damage due to shot-hole borer can be realised. Considering the potentialities of damage and the serious nature of attack in Ceylon, chemical control of this pest was started. Experiments in Ceylon on the control of shot-hole borer by spraying the bushes with Dieldrin soon after pruning have shown that this insecticide is effective. Preliminary experiments on the chemical method of prevention of shot-hole borer have been conducted using two insecticides, namely, Dieldrex and Gamalin. These insecticides were sprayed on clean pruned tea, covering thoroughly the entire frame. Both insecticides have given encouraging results with regard to the percentage kill of beetles within two or three months after treatment. These trials, mostly started at the end of October, have not run long enough to assess the results fully.

GREEN FLY

This insect, identified as *Empoasca flavescens*, was noted to have caused considerable damage to tea in an estate in South Travancore. This pest was first recorded in 1956 from an estate in Central Travancore. The characteristic features of its attack were the hardening and browning of the leaf veins, premature hardening of the leaf and its failure to reach normal size, yellowing of the leaf blade and a tendency for the affected leaf to curl downwards at the edges. Dadaps were also very seriously attacked, but on identification the insect attacking dadaps was found

to belong to a different species. The attack by this pest had become chronic and quite widespread in the estate. There was a considerable loss of crop. In Darjeeling, Green fly attack is supposed to contribute to the flavour of tea and nothing is done to check its activities there. Whether a similar improvement in flavour results from its attack in South India is extremely doubtful. The supposed improvement in quality may not be commensurate with the loss of crop. So, it was suggested that a spray of DDT be given at a concentration of 1 lb. of 50% wettable powder in 20 gallons of water applied at the rate of 40 gallons per acre.

MINOR PESTS

The following are minor or occasional pests noted during the year :—

Tea

1. Aphis, *Toxoptera aurantii* Boyer
2. Leaf miner, *Melanagromyza* sp.
3. Tea Tortrix, *Homona coffearia* Nietn.
4. Tea Leaf Roller, *Gracilaria theivora* Wlsn.
5. Red slug, *Heterusia virescens* Butl.
6. Scale insect, *Ceroplastes* sp.
7. Faggot worm, *Clania crameri*.
8. Eelworm, *Meloidogyne* sp.
9. Nettlegrub.

Shade tree

Dadap.

1. *Myloccerus viridanus* (Weevil)
2. *Sthenias grisator* Fb (Ringer)

Red Gum

1. *Phassus* sp.

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It is a pleasure to acknowledge with gratitude the assistance received from Mr. P. W. Davidar, Manager, Arnakal Estate, during the period of my stay on Arnakal Estate. Grateful acknowledgement is also made of the hospitality received from the Managers of Estates visited during the year. It is also a pleasure to acknowledge the help received from various firms which have very generously sent us samples of their products for tests.

N. R. ANANTHAKRISHNAN,
Entomologist.

APPENDIX

FIRST PROGRESS REPORT ON TEA SELECTION

K. S. VENKATARAMANI

Work on tea selection on high elevation estates on the Nilgiris was started by the UPASI Tea Scientific Department in April 1961. To begin with, investigations on tea selection were made on two estates close to Coonoor, where facilities were offered by the managements. Owing to lack of assistance in the form of technical personnel, selection had to be confined to these estates during the year under review.

Selection was concentrated on five fields in one estate and one field in the other, the fields being one to two years from pruning. Initial marking of the bushes was done by eye-judgment, examining almost every individual bush for such features as recovery from pruning, wood formation, branching habit, flushing behaviour, colour and size of leaves, and pubescence of leaves and buds. A short note on tea selection has been published already in the *Planters' Chronicle*, volume 56, December 15, 1961, p. 438, and it is not the intention now to enlarge on the procedure adopted in marking bushes by eye-judgment. The bushes which appeared promising were staked and numbered, and by a second examination of the marked bushes, a further drastic reduction was made in the number of bushes left for yield and quality tests. The surface area of each of the selected bushes was determined with the help of the two diameters of the bush at the level of the plucking table; this, of course, gives only an approximate area. The bushes were plucked for 12 continuous rounds and at each harvest, the crop from each bush was weighed to the nearest gramme. The flushing behaviour of each bush was examined by counting the number of flush and banji shoots at each harvest, but this was given up at a later stage, as examination of the crop for a short period of 12 weeks was not likely to provide any useful information.

It was, of course, realised that yield records for only 12 rounds of plucking would not indicate the real yields of the selections, but it was felt that such records should serve the purpose of assessing the comparative yielding capacities of the bushes during the particular period. In fact, the respective field yields (fresh leaf weight) during the period the bushes were under observation in the different fields were obtained from the estate for comparison purposes. All yield data were converted to a unit basis (viz. a square foot or 0.093 sq. m.); why this was considered necessary will be explained later. The average bush area in the field was obtained by determining the area of several random bushes and thus striking an average. The yield potential of the selected bush was obtained by dividing the bush yield per unit area by the field yield per unit area. The data thus obtained are presented in Table 1.

Reverting to the question of yield per unit area, it may be mentioned that the size of the bush does not always bear a direct relationship with the cropping capacity. A big bush need not necessarily yield a heavy crop. Similarly, the small size of a bush need not necessarily mean that it is a poor yielder. Yield is directly correlated with the branching habit and flushing behaviour of the bush. To cite a few examples, selection Nos. 15 and 22 in the series B6-A have large surface areas of 4.371 and 4.836 sq. m., respectively, but their yield potentials are low (1.7 and 1.9 respectively). In the same series, selection Nos. 51 and 53 have small surface areas of 1.488 and 1.209 sq. m. respectively, but their yield potentials are high (4.9 and 4.8 respectively).

It can be seen from the data presented in Table 1 that there is a tremendous variation in the yielding capacity of the bushes, ranging from 1.2 to 4.9 times the field yield during the period of study. Bushes in series B4 and BS4 were plucked during the same period of 12 rounds and the bushes within this series could, therefore, be compared one with the other. All the bushes in series B5 were under study during a different period and the 21 bushes in this series could be compared one with the other. The series B6A and B6B were under test in two different periods, but all the bushes within a series were plucked during the same period and are comparable. Examining the 89 selections under test, it could be seen that 76 (or slightly over 85% of the total) have an yield potential falling within the range of 1.8 to 3.5 times the field yield (26.9%, 32.6% and 25.8% in the ranges 1.8 to 2.3, 2.4 to 2.9 and 3.0 to 3.5 respectively).

Descriptions of these bushes together with preliminary observations on resistance to blister blight and rooting capacity of cuttings taken from mature bearing bushes are being prepared. Detailed botanical descriptions of the most promising amongst these selections will be attempted later.

Shoots from the individual bushes were plucked to a standard of two leaves and a bud, withered (medium wither giving an outturn of 45 to 48% made tea to withered leaf), passed through a meat mincer, fermented, and fired in an electrically operated miniature dryer. For want of a miniature dryer, this important aspect of tea selection was delayed considerably and it was only towards the end of the year that a dryer was available for our use. Now with the availability of a dryer, this aspect of work will receive the utmost attention in the future. Several manufactures had to be made initially to standardise the procedure of miniature manufacture. Teas thus made from the individual bushes were tasted and commented on by two tea tasters. Two to five manufactures were made from each selection, each at a different period.

Although it will be rash to make precise statements on the quality of teas made from individual bushes on the basis of a limited number of manufactures, the data so far obtained are presented in Table 2 only with the object of pointing out what variations occur from bush to bush with respect to quality.

Cuttings from these selections have been put out for rooting and rooted cuttings from some of the earlier selections are being transplanted into polythene bags in the nursery. The growth performance of clonal plants thus raised has still to be studied. Besides the work reported here, selections have also been made on two other estates in cooperation with the managers of those estates; the data collected so far have yet to be collated and studied.

It is premature to comment further on these selections or release any of them for estate planting. The indications, however, are that at least ten promising selections, both with respect to yield and quality, are likely to result from this preliminary investigation on tea selection. They are being studied further and detailed notes on the selections which are likely to prove valuable will be published at a later date.

In conclusion, I have pleasure in acknowledging with gratitude the most willing cooperation and assistance which I have received from Messrs. R. Luff and D. E. H. Panter of Carritt Moran & Co., Cochin and Mr. T. N. Nair of Planters Company, Coonoor in sampling and tasting several clonal teas.

TABLE 1.
Bush Yield (Green leaf) and yield per unit area of
0.093 sq. m (1 sq. ft.) for 12 plucking rounds.

Series	Selection No.	Surface area of bush (sq. m.)	Bush Yield (kg.)	Bush yield per unit area (g.)	Yield potential (X field yield)
B4	141	1.860	1.176	58.8	3.1
	142	2.232	1.595	66.5	3.5
BS4	5	2.604	1.327	47.4	2.5
	6	1.860	1.271	63.5	3.3
B5	62	1.209	0.700	53.8	2.8
	63	1.860	1.271	63.5	3.3
	64	1.488	0.470	29.4	1.5
	65	1.953	0.762	36.3	1.9
	66	2.604	1.327	47.4	2.5
	67	1.860	0.944	47.2	2.5
	68	1.953	1.315	62.6	3.3
	69	1.674	1.009	56.0	2.9
	70	4.371	1.676	35.6	1.9
	71	3.627	1.599	41.0	2.1
	72	1.395	0.883	58.8	3.1
	73	3.431	2.298	62.1	3.2
	74	2.325	1.504	60.1	3.1
	75	3.534	2.131	56.1	2.9
	76	1.860	0.738	36.9	1.9
	77	2.232	0.908	37.8	2.0
	78	2.046	1.460	66.4	3.5
	79	2.046	1.172	53.2	2.8
	80	2.604	1.594	56.9	3.0
	81	2.232	1.753	73.0	3.8
	82	2.232	1.113	46.3	2.4
B6A	7	2.604	2.058	73.5	3.2
	8	2.046	1.633	74.2	3.2
	9	2.325	1.293	51.7	2.2
	10	2.232	1.210	50.5	2.2
	11	1.860	0.934	46.7	2.0
	12	1.395	1.043	69.5	3.0
	13	1.860	1.330	66.5	2.9
	14	2.232	1.524	63.5	2.7
	15	4.371	1.885	40.1	1.7
	16	1.860	1.170	58.5	2.5
	17	1.860	0.861	43.1	1.8
	18	2.046	1.530	69.5	3.0
	19	1.209	0.809	62.2	2.7
	20	2.046	0.970	44.1	1.9
	21	2.046	1.424	64.7	2.8
	22	4.836	2.298	44.2	1.9
	23	2.232	1.377	57.4	2.5
	24	2.604	1.988	71.0	3.1
	25	2.883	1.700	55.0	2.4

TABLE 1. (Continued)

Bush Yield (Green leaf) and yield per unit area of
0.093 sq. m. (1 sq. ft.) for 12 plucking rounds.

Series	Selection No.	Surface area of bush (sq. m.)	Bush Yield (kg.)	Bush Yield per unit area (g.)	Yield potential (X field yield)
B6A	26	2.232	0.864	36.0	1.5
	27	2.325	1.541	61.6	2.6
	28	2.046	1.102	50.1	2.2
	29	2.325	0.703	28.1	1.2
	30	1.953	1.217	58.0	2.5
	31	2.604	2.801	100.0	4.3
	32	2.604	1.293	46.1	2.0
	33	2.418	1.637	63.0	2.6
	34	2.604	2.183	78.0	3.4
	35	1.953	0.868	41.3	1.8
	36	1.953	1.676	79.8	3.4
	37	2.604	1.595	57.0	2.5
	38	1.860	1.342	67.1	2.9
	39	1.953	0.821	39.1	1.7
	40	3.534	1.869	49.0	2.1
	41	2.232	1.068	44.5	1.9
	42	1.581	0.979	57.6	2.6
	43	1.860	1.056	52.8	2.3
	44	1.209	0.751	57.7	2.5
	45	2.325	1.703	68.1	2.9
	46	2.232	1.274	53.1	2.3
	47	1.581	0.782	46.0	2.0
	48	2.232	1.547	64.4	2.8
	49	2.604	1.164	41.6	1.7
	50	3.534	1.760	46.3	2.0
	51	1.488	1.818	113.6	4.9
	52	2.046	1.297	59.0	2.5
	53	1.209	1.452	111.7	4.8
	54	2.232	0.670	27.9	1.2
	55	1.581	1.301	76.5	3.3
	56	1.860	1.421	71.0	3.1
	57	2.697	1.634	56.3	2.4
	58	2.604	1.135	40.5	1.7
	59	2.604	1.949	69.6	3.0
	60	1.674	0.675	37.5	1.6
	61	2.232	1.478	61.5	2.6
	62	2.697	1.896	65.3	2.8
B6B	127	2.232	1.224	51.0	3.0
	137	3.534	2.069	54.4	3.2
	138	2.046	0.860	39.1	2.3
	139	2.604	0.857	30.6	1.8
	140	2.232	0.857	35.7	2.1
	141	2.232	1.306	54.4	3.2
	142	1.581	0.809	47.6	2.8

TABLE 2

Valuation of teas made from individual bushes

Series	Selection No.	* Infused leaf	* Colour of liquor	* Strength	* Quality	* Flavour	** Rank	Remarks
B4	141	3	7	5	6	9	A	
	142	6	8	5	7	8	A	
BS4	5	10	9	10	9	8	A	} Nice teas
	6	9	9	9	9	9	A	
B5	63	10	7	7	8	8	A	Useful tea
	66	3	2	5	3	3	C	
	67	4	8	6	6	6	B	
	68	4	8	5	5	5	B	Good tea
	69	8	7	7	8	9	A	
	73	4	6	5	6	8	A	
	75	6	8	7	7	6	A	
	77	4	7	5	5	5	B	
	78	0	6	5	3	3	C	
	79	0	7	4	4	6	B	
	80	0	4	4	3	3	C	
	81	0	7	4	5	4	C	
	82	0	8	6	8	9	A	
B6A	7	7	7	6	5	5	C	Good flavour
	8	8	8	8	8	7	A	
	9	8	8	8	8	7	A	
	10	8	8	7	6	6	A	
	11	7	8	7	8	8	A	
	12	8	8	8	7	6	A	
	13	6	7	5	9	6	C	Poor & slow fermenting
	14	7	8	7	7	7	B	
	15	7	7	7	5	5	B	Poor & slow fermenting
	16	7	7	7	5	5	B	
	17	8	8	8	7	7	A	
	18	6	8	8	6	5	B	
	19	7	7	8	7	6	A	
	20	4	5	4	2	2	C	
	21	7	8	7	6	5	A	
	23	5	7	5	5	5	B	

* Maximum marks possible = 10

** A = Above average; B = Average, C = Below average for high elevation teas

TABLE 2 (Continued)

Valuation of teas made from individual bushes

Series	Selection No.	* Infused leaf	* Colour of liquor	* Strength	* Quality	* Flavour	** Rank	Remarks
B6A	24	8	8	7	5	5	A	
	25	7	7	5	5	7	B	
	28	7	7	7	5	5	B	
	29	7	8	9	7	7	A	
	30	8	7	6	5	5	B	
	31	6	6	7	6	6	B	
	32	4	7	4	5	5	C	
	33	6	7	5	4	3	C	
	34	6	7	7	5	5	B	
	36	9	8	7	6	5	B	
	42	6	7	7	6	6	B	
	48	8	9	8	7	6	A	
	52	6	7	7	6	6	B	
	53	7	7	7	6	6	B	
	54	2	6	5	4	3	C	
	55	5	5	6	5	4	C	
	56	6	6	5	5	5	C	
	57	9	7	6	8	8	A	
	58	10	8	8	8	7	A	
	59	6	7	7	4	6	B	
	60	8	9	8	8	7	A	
	61	8	8	7	5	5	B	
	62	8	8	7	7	7	A	
B6B	127	8	8	7	6	5	A	Useful
	137	9	8	9	9	8	A	Useful
	138	6	8	7	6	6	C	
	139	0	6	4	4	4	C	
	140	1	8	2	2	1	C	Poor & slow fermenting
	141	7	8	7	7	6	B	
	142	8	8	6	7	8	A	

* Maximum marks possible = 10

**=Above average, B=Average, and C=below average for high elevation teas.

A STUDY OF THE COMPARATIVE EFFICIENCY OF NICKEL COMPOUNDS AGAINST BLISTER BLIGHT DISEASE OF TEA

BY

C. S. VENKATA RAM

INTRODUCTION

It has been previously mentioned that nickel chloride sprayed on tea foliage for the control of blister blight gave dramatic results (5, 6, 9). Application to plots with a high disease incidence brought down infection rapidly (5) and at comparative rates of fungicide per acre, nickel chloride was more efficient than copper (9). Tests in the laboratory and in the field indicated that nickel chloride possesses eradivative control property against *Exobasidium vexans* Massee, the causal fungus (8). As a logical extension of the investigations mentioned in the foregoing, studies were made of other nickel salts for blister blight control under field conditions. The use of certain organic fungicides in combination with inorganic nickel has been observed to improve the performance of the latter against cereal rusts (2, 4), hence mixtures of nickel and dithiocarbamates were also tested.

MATERIALS AND METHODS

Inorganic salts of nickel employed in this investigation were of laboratory reagent grade, while mixtures of nickel and organic fungicides were patented formulations kindly supplied by Messrs. Rohm & Haas Company, Philadelphia, U.S.A., to whom the author is thankful.

In all the experiments, each treatment was replicated four times and randomized. Nickel application was made with pressure retaining knapsack sprayers at the rate of 170 litres of the spray fluid per hectare (approximately 15 gallons per acre), using a low volume T-jet nozzle. Except when using formulated nickel plus organic fungicide mixtures, 0.1% teepol was added to the solutions of the inorganic nickel salt. Spraying was carried out at weekly intervals soon after harvest. From the entire lot of pluckable shoots harvested every week from each experimental plot, a random sample of 100 was picked and these were examined individually to give percentage shoot infection in the plot. The mean of four replicates in a treatment is given in all cases.

RESULTS

Five salts of nickel, namely chloride, nitrate, sulphate, acetate and borate, were compared for disease control in one of the field experiments in the S. W. Monsoon period in 1961. Each of the salts was applied at the rate of 0.42 kg. per hectare (6 oz. / acre) to plots comprising two rows of five bushes of tea in the second year of pruning, the first application being made on June 3. Control plots were left untreated.

TABLE I.

Percentage blister blight infection in control and nickel treatments
recorded from June to August, 1961

Treatment	Percentage shoot infection on										Average shoot infection
	23/6	30/6	7/7	14/7	21/7	28/7	4/8	11/8	18/8	25/8	
1. Nickel chloride	4.2	7.5	4.2	18.0	28.7	25.2	42.7	28.5	9.2	8.2	17.6%
2. Nickel nitrate	5.2	7.2	3.7	37.0	40.2	31.2	52.5	41.5	20.5	19.5	25.8%
3. Nickel sulphate	5.8	14.8	8.2	53.7	65.7	44.5	54.0	52.0	24.5	24.5	34.7%
4. Nickel acetate	7.5	8.2	8.0	60.7	50.7	41.5	57.7	50.2	38.7	22.2	34.5%
5. Nickel borate	7.2	14.0	8.2	56.7	43.2	36.2	60.0	51.5	26.2	20.0	32.3%
6. Control, Untreated	47.2	51.0	52.0	91.7	96.0	95.0	97.0	81.2	59.2	67.7	73.8%
P = 0.05	5.4	8.6	9.6	14.0	13.0	16.0	16.7	13.3	11.1	9.7	

It is seen from the results obtained (Table I) that percentage shoot infection in the nickel chloride treatment was significantly lower than in the other nickel treatments during certain of the assessments. At the beginning of the experiment when infection ranged at 50% level in untreated control, chloride, nitrate, sulphate, acetate and borate of nickel gave protection which was not different when analysed statistically. Starting from July 14 for a period of 5 weeks blister incidence was very high and the test conditions were severe with a little over 115 cm. of rain falling from July 1 to August 7. Under these severe conditions nickel nitrate, sulphate, acetate and borate failed to give satisfactory results, only nickel chloride gave adequate disease control. In the August 18 and 25 assessments also chloride outperformed the other salts tested, infection in the nickel chloride treatment being significantly lower than in the others.

The efficiency of nickel and dithiocarbamate mixtures was compared with nickel chloride, at equal rates of fungicide application, in another experiment laid out in a tea field in the second year from last prune, also in the S. W. Monsoon period. Maneb (manganese ethylene bisdithiocarbamate), Zineb (zinc ethylene bisdithiocarbamate), both with and without nickel sulphate, and nickel chloride, all at the rate of 0.42 kg. in 170 litres of water per hectare, were each sprayed in quadruplicate plots of one row of twelve bushes each, the first application being made on June 15. Results are incorporated in Table II.

TABLE II.

**Comparative efficiency of nickel chloride and nickel plus
dithiocarbamate mixtures in the control of blister blight.**

Treatment	Percentage shoot infection on										Average shoot infection
	5/7	12/7	19/7	26/7	2/8	9/8	16/8	23/8	30/8		
1. Maneb	10.5	29.0	67.0	65.2	22.0	81.7	34.5	16.5	26.0	44.7%	
2. Nickel+Maneb	8.7	30.0	71.5	59.5	66.7	68.5	35.5	14.5	24.7	42.2%	
3. Zineb	14.5	38.0	75.0	72.5	76.0	75.7	29.5	18.0	33.0	48.0%	
4. Nickel+Zineb	12.7	35.7	87.7	59.2	80.2	77.0	33.5	11.7	27.7	48.4%	
5. Nickel chloride	6.5	10.2	27.2	27.0	24.2	21.5	8.7	6.5	24.0	17.3%	
6. Control, Untreated	28.7	75.7	99.0	90.2	96.5	92.2	67.0	49.0	65.2	73.7%	
P = 0,05	7.4	10.9	15.8	11.5	13.5	11.2	11,8	9.8	9.6		

At no time during the the entire experiment did the mixture of nickel and dithiocarbamates give significantly better protection than the dithiocarbamates alone (Table II). At the rate of application employed, i.e., 0.42 kg. per hectare (6 oz./acre), the dithiocarbamates, either with or without nickel sulphate, gave unsatisfactory disease control, the average percentage shoot infection for the trial ranging from 42 to 48 in these treatments. In contradistinction, excellent blister control was achieved with nickel chloride, with only 17.3% average shoot infection.

Results obtained with the nickel and dithiocarbamate mixture (Table II) were irreconcilable with the reports of its excellent performance in the control of wheat stem rust (2, 3). The manufacturers recommend use of this mixture at 2 lb./acre (2.24 kg. / hectare) and it was deemed that the usual rate of fungicide application against blister blight, namely 0.42 kg. / hectare (6 oz./acre), was inadequate. Therefore Maneb and the mixture of nickel plus Maneb were tested at the rate of 1.12 kg. and 2.24 kg. per hectare, 1 and 2 lb. per acre, respectively. For comparison, treatments were run with nickel chloride and nickel hydroxide at the usual rate of application. The trial was undertaken in the N. E. Monsoon period in a second year field. Results are presented in Table III.

TABLE III.

Influence of concentration on blister control with dithiocarbamate and nickel plus dithiocarbamate.

Treatment	Rate per hectare	Percentage shoot infection on					Average shoot infection
		25/10	1/11	8/11	15/11	23/11	
1. Maneb	1.12 kg.	10.0	20.7	19.2	10.5	14.2	14.9
2. Maneb	2.24 kg.	3.5	3.5	9.0	4.7	4.2	5.0
3. Nickel + Maneb	1.12 kg.	3.2	9.5	17.0	7.2	4.5	8.3
4. Nickel + Maneb	2.24 kg.	2.2	3.7	6.2	4.7	3.0	4.0
5. Nickel chloride	0.42 kg.	5.5	15.0	27.2	10.5	5.7	12.8
6. Nickel hydroxide	0.42 kg.	6.0	18.0	27.2	14.7	17.2	16.6
7. Control, Untreated		47.7	92.0	82.5	63.5	78.2	72.8
P = 0.05 =		6.3	7.9	7.6	7.1	10.5	

It is readily seen that Maneb, with and without nickel, gave excellent disease control when the rate of fungicide application was at or above 1.12 kg per hectare (Table III). Maneb at 2.24 kg. was significantly better than at 1.12 kg per hectare in three out of the five assessments. At 1.12 kg. per hectare blister control obtained with Maneb plus nickel mixture was significantly greater than with Maneb alone in two out of the five assessments, but at 2.24 kg. differences were insignificant throughout.

DISCUSSION

Nickel chloride gave consistently better blister control than did the other compounds of nickel tested (Table I). It is, however, interesting to observe that against the 35% level suggested by Webster and Park (10) for delimiting satisfactory protection against blister blight, nickel nitrate, sulphate, acetate and borate would also fall within the group of fungicides which give adequate disease control. The average percentage infection in nickel nitrate, sulphate, acetate and borate treatments was 25.8, 34.7, 34.5 and 32.3, respectively. It has been previously observed that crop loss results when average infection exceeds 35% (7). Nonetheless, with the high shoot infection recorded in the nitrate, sulphate, acetate and borate treatments on many occasions, taken in conjunction with the fact that a high average percentage disease was recorded in these treatments, it is doubtful whether the use of these nickel salts could be recommended.

The amount of nickel as metallic, applied in each of the treatments, did vary as for instance the nickel content in the chloride, nitrate, sulphate and acetate is approximately 25, 20, 23 and 24 per cent, respectively. But it may be pointed out that the differences are narrow and apart from nickel chloride treatment which received the maximum nickel as metallic, in the case of the other treatments there was no linear relationship between the dosage of nickel as metallic and blister control. For example, in nickel nitrate treatment which received less dosage of nickel than did sulphate and acetate, percentage shoot infection was also considerably less. Again, the amount of nickel was very nearly the same in the treatments with chloride and acetate compounds, but the former gave significantly better control than did the latter.

Results obtained by the American and Hungarian workers with nickel compounds against rusts may be worthy of mention here. Keil, *et. al.*, (4) ranked nickel compounds in the following order from protective tests against *Puccinia rubigo-vera* (rye leaf rust): acetate=chloride > nitrate=sulphate > hydroxide, but as eradicants the first four were graded equally. Curiously enough the Hungarian workers (1) found nitrate to be slightly superior to chloride in field tests against the mint rust fungus, *Puccinia menthae*. From the present tests the order of rating of nickel compounds in controlling blister blight is: chloride > hydroxide=nitrate > borate=acetate=sulphate. But in eradivative tests in the laboratory, chloride, nitrate, sulphate and acetate gave comparable results (8).

Admixture of zinc ethylene bisdithiocarbamate with nickel sulphate has been reported to improve control of leaf and stem rust of three varieties of wheat when compared to disease control achieved with nickel sulphate alone (2). Keil, *et. al.*, (7) indicated that the eradivative properties of nickel salts against rust were impaired in rain and the protective properties lost completely, but with the incorporation of zinc ethylene bisdithiocarbamate to nickel chloride the mixture was more efficient as a protectant and eradicant than the nickel salt. In the present investigation zinc and manganese salts of ethylene bisdithiocarbamate, with or without nickel, were ineffective (Table II) at 0.42 kg. of the fungicide per hectare (6 oz./acre). But at 1.12 and 2.24 kg./hectare, 1 and 2 lb. per acre, respectively, manganese ethylene bisdithiocarbamate (Maneb) gave excellent protection with or without nickel (Table III). At 1.12 kg./hectare, but not at 2.24 kg., somewhat better disease control was obtained with the nickel plus Maneb mixture than with Maneb alone. It is gratuitous to mention that at the rate of 1.12 kg. in 170 litres of water per hectare, applied with pressure retaining knapsack sprayers, the cost of treatment with nickel plus Maneb mixture will be exceedingly high. However, it would seem worthwhile investigating the efficiency of blister control likely to be achieved with application of this fungicide with motorized mist blowers. By this method of spraying the cost of application will be slashed down considerably, more than compensating for the increased cost of the fungicide. Studies are being initiated on these lines.

SUMMARY

1. Chloride, nitrate, sulphate, acetate, borate and hydroxide of nickel were compared for efficiency in controlling blister blight disease of tea.

2. Nickel chloride gave better blister control than did the other compounds tested, following being the order of effectiveness: chloride > nitrate = hydroxide > borate = acetate = sulphate.

3. Mixtures of nickel sulphate and manganese and zinc salts of ethylene bisdithiocarbamate were ineffective at 0.42 kg. of the fungicide per hectare (6 oz./acre). At dosages of 1.12 and 2.24 kg., nickel plus the manganese salt gave excellent protection. At the higher of these two dosage levels comparable blister control was also achieved with the manganese salt alone, but at the lower dosage the manganese salt with nickel gave somewhat better protection than without nickel.

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APPLICATION OF COPPER AND NICKEL FUNGICIDES WITH MOTORIZED MIST BLOWERS FOR BLISTER BLIGHT CONTROL. 1. RESULTS OF PRELIMINARY EXPERIMENTS

BY

C S. Venkata Ram

INTRODUCTION

In the past ten years of blister blight control much research has been carried out in screening fungicides, from all of which until recently copper formulations emerged as superior to any other tested. In 1960 and 1961 field trials in this Station nickel chloride manifested eradivative action against the causal fungus, *Exobasidium vexans* Masee, and gave better protection than did copper fungicides (7, 8). The cost of nickel vis-a-vis copper being high, economising on cost of application became obviously a possibility for exploration. In Ceylon, the use of motorized mist blowers has lately been found to give effective blister blight control at considerable saving in cost when compared to spraying with pressure retaining knapsack sprayers (2, 5). Not long ago, Loos (4) had raised doubts as to the popularity of knapsack type mist blowers, both on the basis of cost as well as difficulty in handling on steep terrains. Although the introduction of more sophisticated, lighter and cheaper models in recent years perhaps brightened the prospects of their use in tea plantations, a strong impetus has also been given by the mounting labour wages which has considerably put up cost of application with conventional sprayers. Further incentive to the use of mist blowers in Ceylon came out of necessity, from the fact that the suggestion to time fungicide application based on sunshine records (6) made spraying of large areas in a single day inevitable, a feat which could be accomplished only by power operated mist blowers. The purpose of the present investigation was to determine the efficiency of blister control by mist blowing with nickel and copper fungicides under varying conditions; preliminary results are reported here.

RESULTS

Nickel chloride hexahydrate (laboratory reagent grade) and Fytolan (50% copper metallic as oxychloride) were applied at 0.21 kg. and 0.42 kg., respectively, in 35 litres of water per hectare with a "Kiekens Dekker" mist blower (3 and 6 oz., respectively, in approximately 3 gallons per acre). For comparison, Fytolan at 0.42kg. in 170 litres of water per hectare (6 oz. in 15 gallons per acre) was sprayed with knapsack sprayers. The experiment was laid out in a second year field with each treatment replicated four times and randomized. There were 8 rows of 30 bushes each in a plot. Application with mist blower was based on covering 3 rows on each side of the spraying lane, the farthest two being left as guard rows. The pluckable

shoots in the first, second and the third row from the spraying lane were separately harvested and from each a random lot of 100 was picked for individual examination and blister assessment. Fungicides were applied at 7-day intervals soon after plucking commencing from October 3, 1961

Figures for percentage shoots with blisters in the first, second and third rows in nickel and copper misting treatments during each assessment are plotted in Fig. 1. It is readily seen that differences between nickel and copper treatments were narrow throughout. Infection was somewhat higher in the third row compared to the first and second from the spraying lane in both nickel and copper treatments. Differences in blister infection between first and second rows were negligible. The average blister infection was low throughout in plots in which fungicide treatment was carried out with mist blower (Table I), indicating excellent protection achieved with this method of fungicide application.

TABLE I.

Blister control obtained with mist blowing fungicides in comparison to that with application by knapsack sprayers.

Fungicide	Rate per hectare.	Method of spraying.	Percentage shoot infection on					
			30/10	6/11	13/11	20/11	27/11	4/12
Nickel chloride	0.21 kg.	Mist blower	9.2	13.4	10.7	15.4	7.3	4.4
Fytolan	0.42 kg.	Mist blower	9.5	16.0	9.5	15.6	7.6	6.4
Fytolan	0.42 kg.	Knapsack sprayer	12.9	17.3	14.0	20.0	32.0	19.7
P=0.05=			5.8	7.1	6.5	7.3	8.9	8.7

It is also seen from Table I that copper application with pressure-retaining knapsack sprayers at 170 litres of spray fluid per hectare gave satisfactory blister control, but infection in this treatment was higher throughout, and significantly higher on two occasions, when compared to mist blowing treatments.

Admittedly the method of mist blowing in the tea fields would influence the results and it is felt that sufficient experience has not been gained on this question for any firm recommendation. Elias (3) in Ceylon mentions mist application of ten rows in a line, five on each side, at the rate of 30 yards per minute. More recently the Ceylon workers (1) carried out investigations on the effect of sideways blowing as opposed to swinging the nozzle in an arc on deposits produced on glass slides held at various distances. Results were clearly in favour of blowing on one side only,

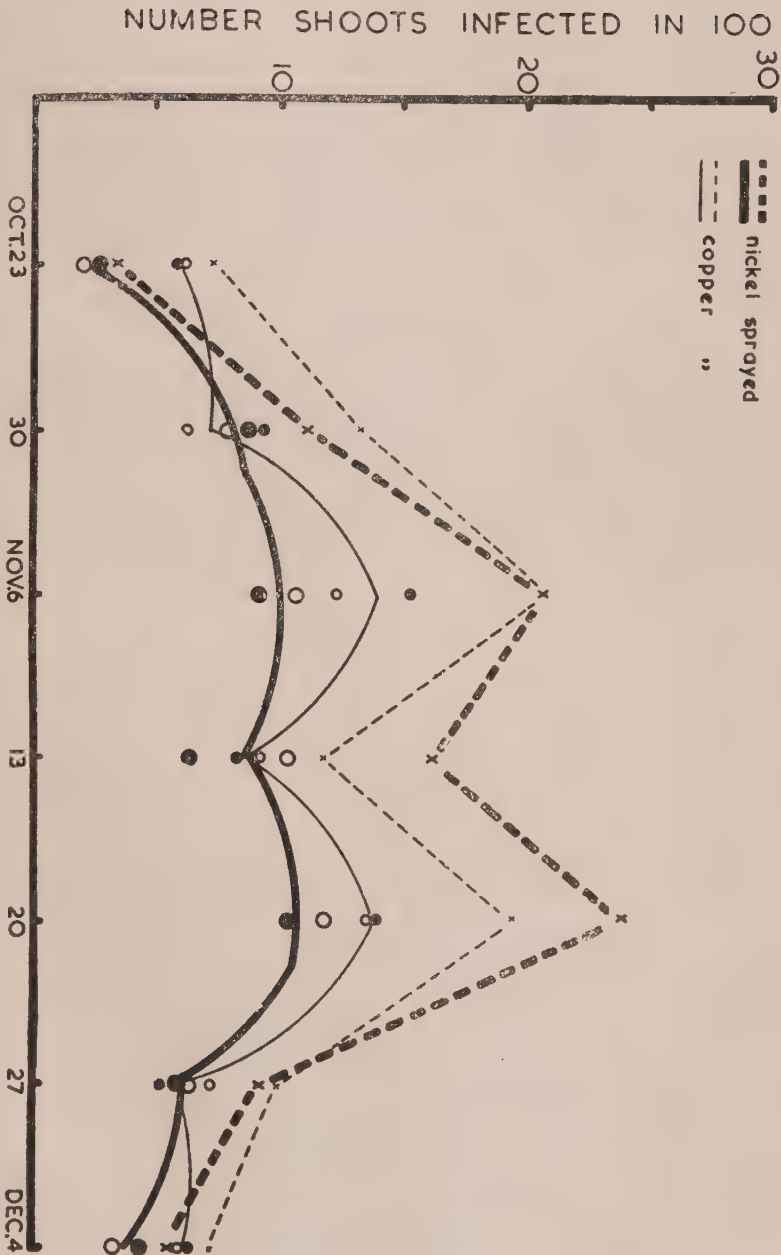


FIG. 1

based on which they recommend mist application with the wind and never against it. Depending on the power of the mist blowers, and the design of the nozzle, from 6 to 10 rows of the bushes can be reached. Be that as it may, the present results support the findings of the Ceylon workers (2, 5) that as good, if not better, blister control is achieved by mist blowing of fungicides as that with knapsack spraying. It was also encouraging to note that nickel chloride at 0.21 kg. per hectare (3 oz./acre) provided excellent blister control. With the cost of labour for mist blowing at approximately Rs. 0.75 an acre (2), or Rs. 2.05 per hectare, application of nickel chloride despite its slightly higher cost compared to copper fungicides would be quite economical.

SUMMARY

Nickel chloride hexahydrate and a proprietary copper fungicide containing 50% metal as oxychloride were applied by motorized mist blowers at the rate of 35 litres of the spray fluid per hectare (3 gallons per acre). Excellent blister control was obtained by mist blowing nickel fungicide at 0.21 kg. and copper at 0.42 kg. per hectare (3 and 6 oz., respectively, per acre). At the same rate of usage of the copper fungicide mist blowing gave better results than application with knapsack sprayers.

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Explanation of Fig. 1

Fig. 1. Blister infection assessed at weekly intervals in nickel and copper treated plots. Fungicide was applied with a mistblower and infection in the third (crosses), second (filled circles) and first (empty circles) rows from the machine determined. Broken lines indicate blister infection in the third row and solid lines the average infection in the second and first rows.

INVESTIGATIONS ON THE USEFULNESS OF SUNSHINE RECORDS IN TIMING APPLICATION OF COPPER FUNGICIDES AGAINST BLISTER BLIGHT OF TEA

By

C. S. VENKATA RAM

INTRODUCTION

There are several methods by which the intensity of a disease of fungal origin could be forecast. As a starting point the conditions essential for the establishment of the pathogen in the host must be accurately determined. Simultaneously, the factors influencing the dissemination of the pathogen should also be investigated. By superimposing the data from both studies on meteorological records for a given period, it is often possible to foreshadow an epidemic. In early studies on tea blister blight caused by *Exobasidium vexans* Massee, spores of the fungus were observed to germinate readily in humid conditions (2). Though spores germinate in drops of water, a thin film of water has been found more favourable for germination (3, 8). There is still doubt as to the lowest relative humidity which will support germination of the blister spores. According to Huysmans the lowest is 97 per cent, but other Dutch workers have observed spores to germinate at 90 per cent relative humidity (7), while still others mention 80 per cent as minimum required for germination (12). Apparently the relative humidity at which the blisters are maintained, prior to spores thereof being taken for germination, influences germination considerably, the lower the humidity of blister incubation the slower the germination (1). Relative humidity also influences spore formation and ejection, the lowest at which these processes occur being 83 per cent according to Huysmans (6) and 80 per cent according to other investigators (7, 12). Taking into account the influence of relative humidity on the blister fungus, Huysmans (6) suggested a system of portending an epidemic in which when the average relative humidity, expressed as 5-day averages, during a period of 10-14 days exceeded 83 per cent a moderate blister attack could be expected, lasting until the 5-day average remained below 83 per cent for 3-5 days. In case during 20-24 days the 5-day averages exceeded 83 per cent, a serious attack would result. Ensuing out of this system of forewarning the disease intensity, the practical recommendations for blister blight were to stop chemical treatment when the 5-day average relative humidity remained below 83 per cent during 3 successive days. On somewhat similar lines Homburg (4) proposed that fungicide application be stopped after a 5-day period when daily relative humidity averaged below 80 per cent, and resumed when the average exceeded the figure, in a period of 3 days.

Perhaps the realization that relative humidity and sunshine are inversely related prompted the Dutch workers to employ sunshine data as a guide to forecasting blister blight incidence. Indeed, it was early observed that exposure of spores to continuous sunlight for 30 minutes proved lethal (6) and van Emden and Reitsma (15) have mentioned that during continuous sunny periods blisters turn brown before sporulating. In 1955 Homburg (5), based on his findings that a negative correlation existed between hours of sunshine in the morning and incidence of the disease, stipulated a critical limit of 5-days with an average of 3 hours morning sunshine; the 5-day average of total morning sunshine falling below 3 hours in a 3-day period signalling the start of fungicide application. The importance of morning hours of sunshine in influencing blister incidence was further stressed by van der Knaap (14) who evolved a system of scoring, with higher scores for less morning sunshine and *vice versa*, the disease intensity being forecast by a score index. The discrimination between morning sunshine and that received subsequently was criticised by de Weille (1), who also doubted whether the relationship between disease incidence and morning sunshine could be used in practice. De Weille likewise employed a system of loading sunshine hours, but regardless of the period in which they were recorded. The system was shown to work satisfactorily in Indonesia.

Observing that the warning systems based on sunshine suggested by the Dutch workers in Indonesia were a little too complex, Visser *et. al.*, (19) and Mulder (9) carried out experiments in Ceylon in which average daily sunshine in a stipulated period prior to application was set at a fixed limit, below which treatment was carried out and postponed when sunshine hours reached or exceeded the limit. As a practical recommendation they suggested postponing fungicide application when sunshine was at a minimum of 16 hours in 4 days preceding treatment on 7-8 day rounds, 20 hours in 5-days on 9-10 day rounds. By doing so the authors claimed reduction in cost of chemical treatment with satisfactory blister control as compared to spraying on regular rounds (10, 11, 19, 20).

That technical knowledge in agricultural and horticultural sciences gained in one country, indeed sometimes in one part of a country, cannot be applied in another need hardly be emphasized. Differences in elevation, terrain and certain climatic factors would render void any generalization of results which correlate meteorological data with disease control. With these facts as background to the present investigations, a number of experiments were carried out in the S. W. and N. E. Monsoon seasons in 1961 to evaluate blister blight control achieved by timing copper fungicide treatment based on sunshine as suggested in the system developed in Indonesia (1) and Ceylon (9, 19).

EXPERIMENTAL

Copper fungicides at the rate of 0.21 kg per hectare in 170 litres of water (6 oz./acre in 15 gallons) were applied with knapsack sprayers. Blister counts were taken by examining 100 shoots picked at random from each plot and the average of all replicates in a treatment expressed as percentage of shoots infected.

In the first trial, laid out during the S. W. Monsoon period in tea in the second year from prune, there were three treatments and one untreated control, each replicated six times and randomized. Individual plots consisted of a row of 12 bushes. A proprietary copper fungicide with 50% metallic content as oxychloride was used. Applications were made starting from June 5 on 1) regular 7-day rounds, 2) on 7-day rounds, but application being postponed by 4-days when total sunshine during this period was at a minimum of 16 hours as suggested by the Ceylon workers (9, 19), and 3) on 3-4 day rounds according to the system evolved in Indonesia (1), but treatment being discontinued when the sunshine valuation rate (S.V.R.) reached or exceeded 40 and resumed when S. V. R. fell below 40, the minimum interval between two applications being never less than 3-4 days. Calculations of S. V. R. were made by summing on a 7-day period the values for sunshine hours on the 1st, 2nd, 3rd and 7th day and twice the values for 4th, 5th and 6th day. For the sake of convenience the two systems for timing fungicide application will be referred to as the Ceylon and S. V. R. systems. Examinations for blisters were made at 7-day intervals and results are given in Table I.

Weather conditions throughout June and July 1961 were severe, total sunshine recorded was 65 and 25 hours and rainfall 50.62 and 108.35 cm., respectively. Spraying could be postponed only once by 4-days in the Ceylon system of timing treatment, but the total number of applications remained the same as in regular 7-day rounds (Table I). Blister infection was also comparable in both treatments.

TABLE I.
Influence of timing fungicide application on blister infection

System of application	Total No. of treatments	Percentage shoot infection on								
		17/7	24/7	31/7	7/8	13/8	21/8	28/8	4/9	Mean
Regular 7-day	13	54.3	47.2	55.3	75.0	53.0	19.3	48.1	60.0	51.5
Ceylon system	13	51.2	44.2	43.5	72.0	39.3	25.0	59.0	52.3	48.3
S. V. R. system	23	50.7	32.2	19.3	24.5	21.8	11.2	24.3	21.5	25.7
Control Untreated	—	93.5	93.8	93.3	93.0	72.2	61.7	81.1	86.6	84.4
Difference Required for significance $P=0.05$		14.9	13.3	13.8	12.6	14.7	11.4	12.4	10.8	12.9

Spraying on 3-4 day rounds on the S. V. R. system definitely gave much better protection than did spraying on 7-day rounds, but a total of 23 applications in the former as against 12 in the latter were made. S. V. R. was throughout below 40 excepting for a short period of 6 days from June 22 to 27, when it exceeded this figure.



FIG. 1

The second experiment was carried out in the N. E. Monsoon period with exactly the same design and treatments as the first, but using Bordo 77 (cupric hydroxide, containing 40% copper as metal) as the fungicide. First application was made on August 29. Results are presented in Figs. 1 and 2.

The histograms in Fig. 1 represent total sunshine hours received during a 4-day period preceding the date when fungicide application was due. When the figure exceeded 16 spraying was postponed by 4 days. It is seen that after the 1st copper application on August 29, subsequently only 5 were made on the Ceylon system of timing treatment (histograms indicating under 16 hours sunshine). On regular 7-day rounds 13 applications were made. The thick-line curve in Fig. 1 represents percentage disease control achieved when the fungicide was sprayed at regular 7-day intervals, the thin-line curve that when application was timed on the Ceylon system. It is obvious that overall significantly better protection was obtained by uninterrupted spraying than that with timed applications. In the first two assessments the disease control in both treatments was comparable, thereafter, whereas control improved with regular spraying it fell sharply from September 19 to October 3 in the spray-timing treatment. On October 17 the disease control in the two treatments was again comparable, but in October 31 with timing of application control had broken down, while with regular spraying it was the same as on October 17. From October 31 to November 28, based on the sunshine records, no further fungicide treatment on the Ceylon system of timing application was indicated but disease control was also throughout this period significantly less than in the uninterrupted 7-day round treatment.

On a critical examination of Fig. 1 certain interesting features come to light. It is seen that fungicide application in the spray-timing treatment was postponed on September 19 when sunshine in the foregoing 4-day period had exceeded 16 hours. This was immediately followed by a decline in blister control in this treatment. On September 23 and again on September 30 fungicide had to be applied, the effect of which was reflected as a sharp rise in disease control in the assessments on October 10 and 17. From October 4 to 15 a good amount of sunshine was recorded and spraying was not indicated on October 7, 11 and 15. On October 19 application had to be made. In the valuation on October 24, disease control had fallen somewhat and in that on October 31 control had broken down to a very considerable extent. Obviously, this was due to infection occurring just prior to the treatment on October 19.

In Fig. 2 curves are drawn for protection given by Bordo 77 sprayed at regular 7-day intervals (thick-line) and that applied on the S.V.R. system of 3-4 day rounds, but treatment being discontinued when S.V.R. reached or exceeded 40 (thin-line). Also, the figures for S.V.R. on each day starting from the 1st application on August 29 are given on an inverted scale in the lower graph; the periods when S.V.R. was below 40, indicating fungicide treatment, are shaded and the dates on which actual applications were made are marked with arrows.

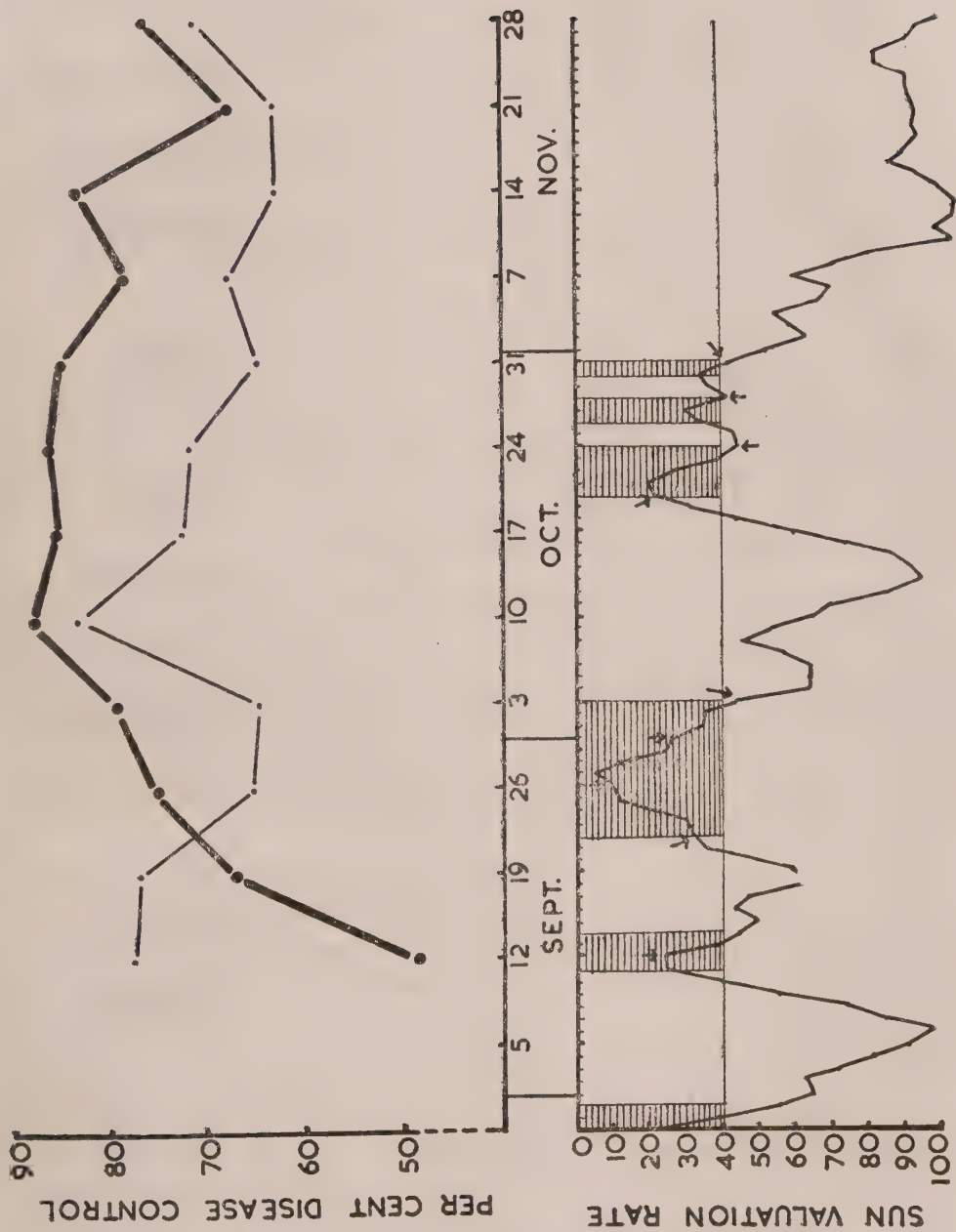


FIG. 2

When spraying was uninterrupted, starting from approximately 50 per cent disease control on September 12, the figures rapidly increased at each subsequent examination till almost 90 per cent control was reached on October 10; blister control remained between 80 and 90 per cent upto November 14 and thereafter declined to 70 per cent. In the S.V.R. system of timing treatment the first application was made on August 29 and the second on September 12, 2 weeks later. Blister control remained at the same level in the first two assessments. After a short period of 3 days from September 11-14, when S.V.R. was below 40 and the second application was made, no further treatment was indicated upto September 21. The following day the third application was made and subsequently another three were carried out at 3-4 day intervals (Fig. 2). It was interesting to note that blister control dropped considerably between the 2nd and 3rd fungicide applications. Consequent on four uninterrupted applications from September 22 to October 3, the figure for disease control again shot up, but when no treatment was carried out, as it was not indicated, from October 3 to 20, an interval of 17 days, blister control again dropped. As seen from Fig. 2, blister control achieved with regular 7-day round application of Bordo 77 was appreciably higher than that with timing application based on S.V.R. with the minimum interval at 3-4 days. In the former case a total of 14, and in the latter 10, applications were made.

Applications in the third experiment were made at 10-day intervals, without interruption and interrupted by postponement of treatment by 5 days when sunshine in the foregoing 5-day period reached a minimum of 20 hours. Infection was recorded at 10-day intervals. Two proprietary 50% copper fungicides, one based on cuprous oxide (Kirticopper 50-W) and the other on copper oxychloride (Fytolan), were used. The experiment was undertaken in the N.E. Monsoon period in a second year field with four replicates in a treatment, each a plot of 2 rows of 10 bushes. The first application was made on September 5.

In Fig. 3 the blister control obtained with Fytolan on interrupted (thin-line curve) and uninterrupted (thick-line, rounds is shown. Sunshine hours on each occasion when application was due in the spray-timing treatment are given as histograms. It is readily seen that spray-timing gave considerably less control than did application at regular 10-day intervals. In the spray-timing treatment blister infection was initially lower than in the regular treatment. Subsequently, however, in the first three weeks in October blister control declined sharply when application was timed based on sunshine records, whereas in uninterrupted 10-day round application control was maintained at the level existing earlier. It is also seen from Fig. 3 that 7 applications at regular 10-day intervals were carried out. The total sunshine hours in a 5-day period preceding application was less than 20 only on three occasions from September 15 to November 27, therefore, during this period only 3 applications on spray timing treatment were made. In the 5 days prior to September 26 only 10 hours of sunshine were recorded and on 26th the fungicide was sprayed. In the assessment on September 26 blister control was about 50 per cent, but on October 6

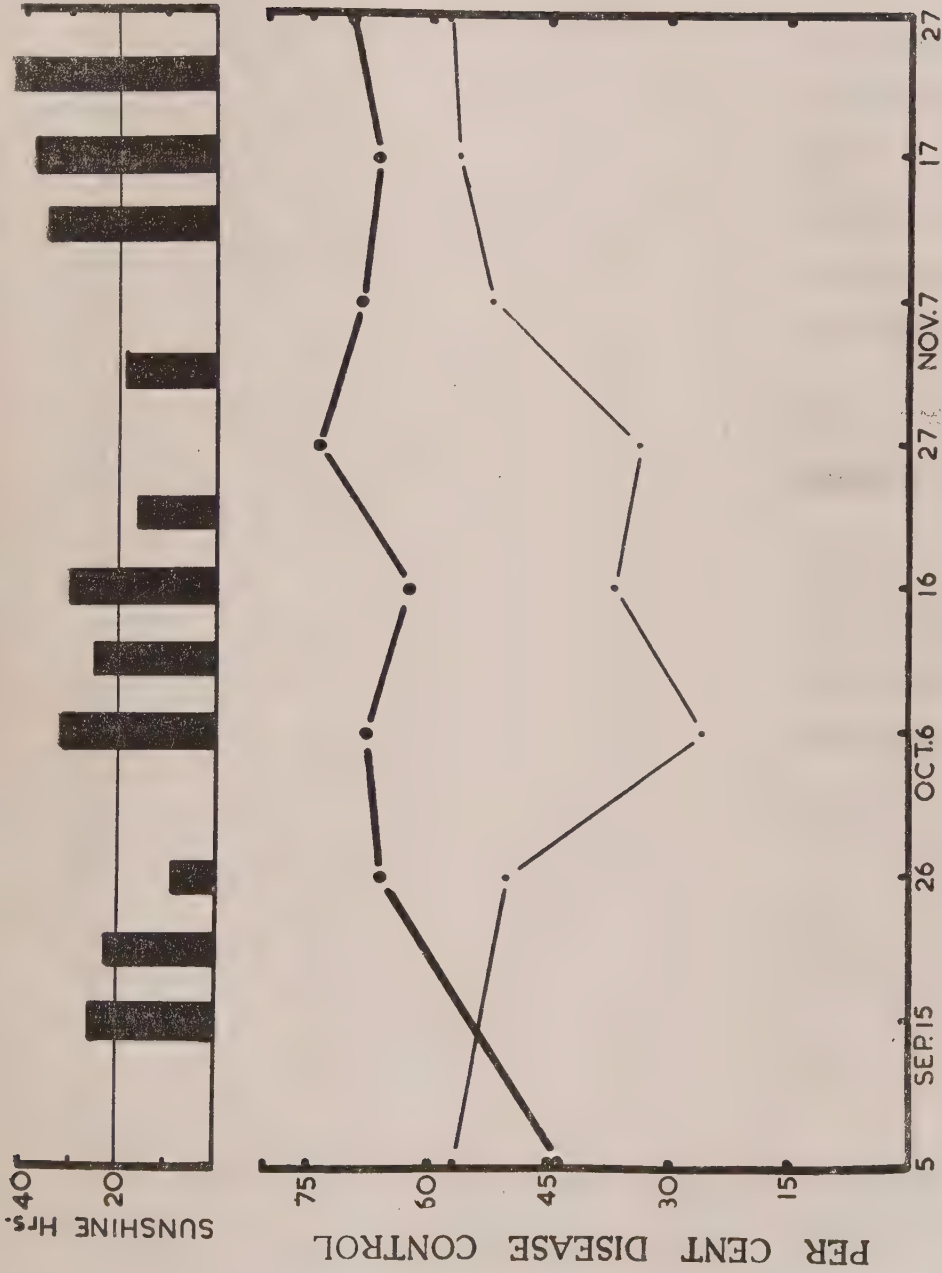


FIG. 3

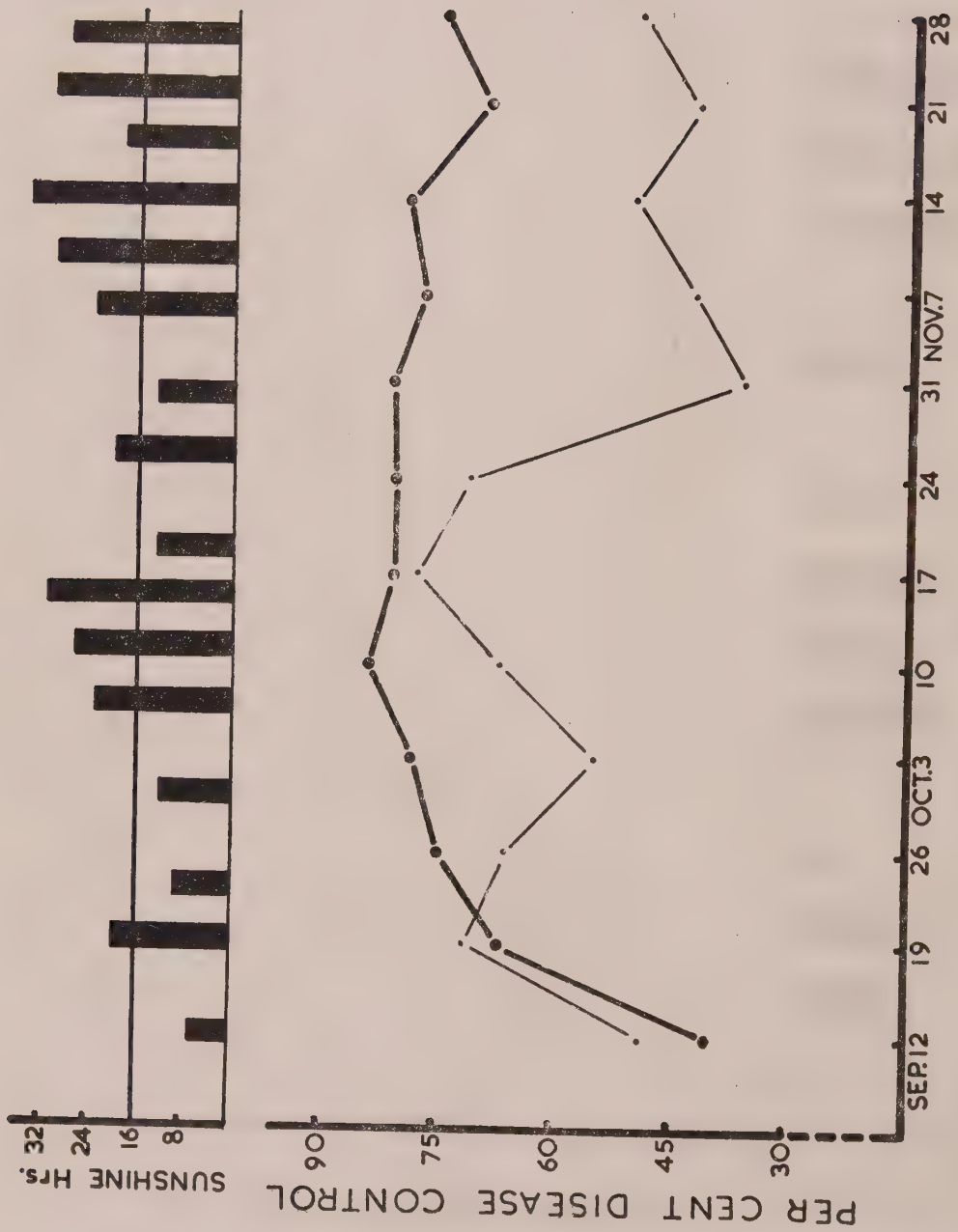


FIG. 4

it had declined very sharply, indicating thereby that the fungicide applied previously was insufficient to halt the wave of infection which must have occurred just prior to September 26 and the application on this date itself was late and consequently ineffective. Subsequent to the steep fall in blister control level registered on October 6, control improved somewhat but continued to be appreciably below that given by the regular 10-day round treatment.

Results obtained with Kirticopper 50-W were also unsatisfactory when the fungicide application was timed on the basis of less than 20 hours of sunshine in the 5-day period prior to treatment (Fig. 4), though the average blister control for the duration of the experiment in this case was somewhat better than that obtained with Fytolan.

DISCUSSION

The chief aims of timing fungicide application based on meteorological data are 1) to carry out treatment when it will remove a serious threat from the disease and 2) minimum rounds of spraying would give profitable control. Two systems of timing application against tea blister blight, one proposed by de Weille (1) in Indonesia and the other by a group of workers in Ceylon (10, 19), have been recently reported to give satisfactory results. However, in investigations undertaken to test the suitability of the two systems for adoption in S. India, results were obtained which do not corroborate those obtained in Indonesia (1) and Ceylon (10, 11, 19). The reasons for this are discussed here.

Conditions from the beginning of June to end of August were severe and no saving in rounds at 7-day intervals was possible (Table I). In most of the tea areas in S. India under the influence of the S. W. Monsoon, weather conditions would very unlikely permit postponement of fungicide application based on sunshine data. During the N. E. Monsoon, however, weather conditions are more intermittent and possibilities exist of saving in rounds, although it is still uncertain how they could be exploited. As seen from the present results, timing of copper treatment based on less than 16 hours of sunshine in the foregoing period of 4 days on 7-day rounds, 20 hours in 5 days on 10-day rounds, as proposed by Visser *et. al.*, (19) and Mulder (10) gave unsatisfactory blister control (Fig. 1, 3 and 4). Also, when spraying round was 3-4 days and treatment carried out only when sunshine valuation rate (S.V.R.) was below 40 as suggested by de Weille (1), results were poor (Fig. 2).

A priori the two factors essential for determination in forecasting disease intensity are the conditions under which infection takes place and the inoculum potential present. De Weille (1) in his experiments observed that blister spores did not germinate in darkness, bright or intense light retarded germination, the maximum germination occurring in diffuse light. He also found that spores exposed to ultra-violet light rapidly lost viability, the lethal effect of sunshine on spores being, therefore, attributed to irradiation. Based on these observations de Weille (1) enunciated

his system of predetermining blister blight intensity. The system employed in practice for timing fungicide application was shown to give satisfactory results in Indonesia. Adhering to the S.V.R. limit of 40 stipulated by de Weille for elevations between 2600 and 3100 feet, the present experiments were carried out at 3300 feet altitude, it was found that blister control broke down when a period of 10 days or more with S.V.R. over 40, indicating no treatment, was followed by a period when it fell below this figure calling for resumption of treatment (Fig. 2). Obviously, conditions optimum for infection at a high level had occurred prior to application of the fungicide when S.V.R. fell below 40. It may be pertinent to mention here the findings of Loos (8) who showed that under optimal conditions spores of *Exobasidium vexans* Masee germinate in 6-16 hours and penetration of tea leaf takes place in 16 hours. Apparently, after an unfavourable period optimal conditions for penetration occur, as seen in Fig. 2, but timing of fungicide application on the S.V.R. system is too late to arrest the established infection. De Weille has probably been influenced by his observations that blister spores do not germinate in the dark, therefore during the daylight hours conditions of atmospheric humidity and surface moisture on the leaf would limit germination. This is very likely a wrong surmise as in the author's experiments (18) blister spores germinated equally well in complete darkness as in light, provided certain other limiting factors were overcome. Again the lethal effect of sunlight on blister spores is more a temperature effect than that of irradiation (18); sunshine in all places at different elevations would not have the same influence on the spores. It is noteworthy that de Weille stipulates the critical limit of S.V.R. at 40 applicable only to elevations between 2600 and 3100 feet, limits of S.V.R. varying for other elevations. Obviously, temperature effect is indicated. Apart from questioning the usefulness of the S.V.R. system as guide to fungicide application on theoretical considerations mentioned in the foregoing, it is doubtful whether a system involving a 3-4 day round would find favour with the grower who is struggling to keep the spraying round to once in 7-10 days. On the aspect of economics, when the system proved superior to regular weekly spraying the cost of application was nearly double (Table I), but when saving in cost of 4 applications was achieved blister control was also appreciably poor (Fig. 2). Whether a S.V.R. limit over 40 would have given better results than what was registered in the present experiment with S.V.R. at 40 is an argumentative point. Perhaps then no saving in rounds would have been possible.

Adverting to the system of timing fungicide treatment recommended from Ceylon (10, 11, 19), admittedly it is a practical system without complexities of calculations and fits in with the normal 7 to 10 day rounds of plucking and spraying. Judging from the results of the present investigation it is, however, doubtful that it could give satisfactory results under conditions obtaining in S. India. Here again the reason for the system proving unsatisfactory is that, after postponing application(s) when sunshine in the stipulated period prior to application exceeds the critical limit, optimal conditions for the establishment of the pathogen could set in,

starting off a severe infection, before the next treatment is carried out thereby rendering it ineffective. This is amply illustrated in Figs. 1, 3 and 4 and further discussion on the point would be gratuitous. As stated earlier, results given by this system in Ceylon were satisfactory. Perhaps under certain conditions of pre-existing low levels of blister infection, as recorded in Ceylon investigations (19), the system works better. Visser *et al.*, (19) recorded only 36.2 per cent mean shoot infection in control (unsprayed plots) in their trials from May to December with the highest figure of 54.8 in July, whereas in the present experiments blister infection in the untreated plots averaged over 70 per cent. Apart from the differences in the macroclimate influencing the experiments here and in Ceylon, as for example mist in the night which was of common occurrence in the author's experiments, certain differences in the microclimate of the host did very likely influence sporulation, germination and penetration of the pathogen. It may also be pointed out that results of spore germination on glass slides set in the field (20), could at the best be used only as an arbitrary index of rate of germination *in situ*, undoubtedly germination on the tea leaf would differ considerably from that on glass slides as it is very likely that certain exudates from the leaf stimulate germination (18). Correlation of spore germination on glass slides in the field with weather conditions would be a weak pointer to influence of microclimate of the tea leaf on spore germination and penetration.

As shown by Tubbs (13) the area of newly exposed leaf tissue increases by approximately 13 times at the end of one week and by 87 times at the end of a fortnight. Our experiments have indicated that regular fungicide application at interval upto 10 days gives good blister control, but at 14-day intervals saving in rounds is uneconomical *vis-a-vis* crop loss (16). If in application based on sunshine records treatment is suspended for 14 days, a tremendous area vulnerable to infection is created which will develop blisters on an epiphytotic scale when conditions conducive to the pathogen obtain. Of course, the fungicide already present on the foliage mitigates the intensity of infection somewhat, but nonetheless, in the two systems of timing application under discussion, resumption of treatment after 10-14 days' interval is definitely after a wave of infection is already established. With protective fungicides this could be disastrous and this explains why timing of application has been found ineffective (Figs. 1-4). It will be ineffective under any system of protective spraying unless the newly exposed leaf area is covered with the fungicide as soon as there is a potential threat of serious infection. But it may be worth examining what blister control would be like on timed application with eradicant fungicides, as for example, nickel chloride which kills the pathogen already established in the host (17). Investigations on these lines are being undertaken.

SUMMARY

1. Investigations were carried on blister blight control under uninterrupted and interrupted systems of spraying with copper fungicides.

2. On 7-day rounds application was postponed by 4 days when total hours of sunshine reached or exceeded 16 in a 4-day period preceding application, on 10-day rounds by 5 days when sunshine was at a minimum of 20 hours in the foregoing 5-day period. In both cases blister control was markedly lower than that achieved when application was made on regular 7-and 10-day rounds.

3. Copper applications were also made at 3-4 day intervals, but treatment suspended when after a minimum period of 3 days following application S. V. R. (sunshine valuation rate) reached or exceeded 40. In this system when disease control was excellent, cost of application worked out to nearly double that on regular 7-day rounds, but when saving in cost of treatment was possible blister control was also commensurately low.

4. With protective spraying, it is doubtful whether under any of the existing systems of timing application which employ sunshine records as guide, satisfactory blister control could be achieved. The reasons for this are discussed.

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Explanation of Figures 1-4.

Fig. 1, showing blister control given by fungicide application at regular 7-day intervals (thick-line curve) and on spray-timing treatment (thin-line). Histograms indicate the hours of sunshine in a 4-day period preceding the date when application was due.

- Fig. 2. Upper graph shows blister control given by fungicide treatment at regular 7-day intervals (thick-lines) and that obtained when treatment was carried out at a minimum interval of 3-4 days, but application being suspended when S. V. R. (sunshine valuation rate) reached or exceeded 40 (thin-line curve). S. V. R. on each date is given in the lower graph on an inverted scale and the actual dates of application are marked with arrows.
- Fig. 3, showing disease control obtained with spraying Fytolan at 10-day intervals, uninterrupted (thick-line) and interrupted (thin-line) by postponing application by 5 days when in this period prior to application the total sunshine was at a minimum of 20 hours. Histograms indicate the hours of sunshine in a 5-day period when treatment became due.
- Fig. 4, showing disease control obtained with spraying Kirticopper 50-W at 10 day intervals, uninterrupted (thick-line) and interrupted (thin-line) by postponing application by 5 days when in this period prior to application the total sunshine was at a minimum of 20 hours. Histograms indicate the hours of sunshine in a 5-day period when treatment became due.

EFFECT OF GRASS ON THE GROWTH OF YOUNG TEA PLANTS

K. S. VENKATARAMANI

Although it is generally recognised that a cover of grass weeds is detrimental to the growth of young tea plants in clearings, it is not known what exactly is the extent of damage caused by such weeds. A simple experiment was carried out with rooted cuttings of a single tea clone and the results are summarized here.

Rooted cuttings of the same age were selected for uniformity of root growth and development of the axillary bud. Two series of eight pots each were filled with tea garden soil, 10 kg. of air-dry soil per pot. One cutting was planted in each pot. In eight of these pots, slips of *Paspalum* sp., a grass weed commonly occurring in some tea areas, were planted on the surface and they were allowed to grow and cover the soil. In the other eight pots, the soil surface was always kept clean weeded. Each pot received an application of 1 oz. of Sterameal at the start of the experiment in December 1960 and a similar application four months later early in April 1961. All the sixteen pots were kept under the shade of woven coirmatting admitting approximately 60 per cent of the light in the open. The pots were watered as and when required without permitting undue leaching. At the end of eight months (August 1961), the plants were carefully lifted from the pots and their roots were washed free of soil. Each plant was then divided into three components, viz. the mother-leaf internode stem, the shoot portion including the original mother-leaf and the roots. These portions were oven-dried and their dry weights determined. The results are presented in the following table:

Components	Dry weight in mg. (8 plants)		Difference required for significance	
	Control series	Grass series	P: 0.05	P: 0.01
Internodal stem of mother leaf	362	289	65.5	--
New leaf and stem	2107	817	481.3	668.0
Total aerial portion	2469	1106	544.1	755.3
Roots	845	338	265.1	368.0

It is evident that the growth of the young tea plant has had a setback owing to the presence of a cover of grass (Fig. 1). Every part of the plant – the mother leaf internodal stem, fresh aerial growth and the roots – was adversely affected as evidenced by the poor dry weight.

Direct competition of tea grass for nutrients and water is known to modify the root development and the resulting growth of perennial horticultural plants, but it is not here considered to be the cause of the stunting of the tea plants, as fairly adequate amounts of nutrients and moisture were supplied. It is probable that the poor growth of the young tea plants under the grass cover may be due to the indirect effects of the grass on nutrient availability or soil structure, or even due to the effect of toxic exudates from the grass. Although there was a marked reduction in the root system, the grass apparently had no effect on the pattern of root growth. The roots under the grass cover, however, were generally more slender than those in the clean weeded soil. It would be of further interest to study the effect of grass weeds on the growth and development of the root system of mature tea bushes and to determine what exactly is the effect of a grass cover on growth and cropping behaviour of tea bushes.



Fig. 1

- A. Tea cutting under a cover of grass.
- B. Tea cutting in clean weeded soil.

ROOTING OF TEA CUTTINGS AS INFLUENCED BY TREATMENT WITH BORON AND INDOLEBUTYRIC ACID

K. S. VENKATARAMANI

Boron, either alone or in combination with growth regulators, has been reported to stimulate the rooting of cuttings of several plant species, such as tomato, coleus, privet, balsam, ivy, bean hypocotyls, capsicum, holly, clematis, rhododendron, *Rhoeo* sp. and *Justicia gendarussa* (1, 2, 3 and 5, 6, 7, 8). An experiment was, therefore, started to determine whether this trace element would have any beneficial effect on routine rooting of tea cuttings in estate nurseries.

Leaf and internode cuttings were obtained from a good rooting tea clone and were treated as follows: basal ends of cuttings were kept dipped for 16 hours in aqueous solutions of boric acid (10, 20 and 40 p. p. m. of boron), boric acid plus indolebutyric acid (IBA 100 p.p.m.), IBA alone and water. They were then rinsed in water and were inserted in a sand-soil rooting medium (pH 5.2) taken in small earthenware pots. The pots were kept under the shade of woven coir-matting and normal tea nursery practices were followed. Each treatment consisted of 12 cuttings; 6 cuttings were examined for rooting 6 weeks after treatment and the remaining six were carefully lifted from the rooting medium and the roots washed free of soil and the dry weights of roots determined 12 weeks after treatment. At the first sampling, root initiation was noticed only in cuttings treated with IBA. The final results are presented in the following table:

Treatments	Dry weight of roots of 6 cuttings (mg.)
Control (water)	1182
Boron (10 p.p.m.)	1195
Boron (20 p.p.m.)	1090
Boron (40 p.p.m.)	833
IBA (100 p.p.m.)	1888
Boron (10 p.p.m.) + IBA (100 p.p.m.)	1859
Boron (20 p.p.m.) + IBA (100 p.p.m.)	1485
Boron (40 p.p.m.) + IBA (100 p.p.m.)	1561
Difference required for significance	
@ P: 0.05	304
@ P: 0.01	406

Conclusion

@ P: 0.05—	<u>EF</u> <u>HG</u> <u>BA</u> <u>CD</u>
@ P: 0.01—	<u>EF</u> <u>HG</u> <u>BA</u> <u>CD</u>

IBA alone promoted good growth of roots and this is in conformity with our previous findings (4). Boron (B) by itself did not exert any beneficial effect on root formation. Even in combination with IBA, B did not prove useful and no synergistic action with IBA was noticed. Above 10 p.p.m., B suppressed root growth even with IBA, although rooting was better than in the untreated control. This may be due to the effect of IBA and it is likely that IBA has to some extent counteracted the ill-effects of B.

Our observations are at variance with those of Bussler (1), Sen *et al* (3), Weiser (5, 6) and Weiser and Blaney (8), who reported beneficial effects of B on both initiation and development of roots in some plant species, either alone or in combination with growth regulators. It must be mentioned here that in the experiments reported by these workers the rooting medium was either a nutrient solution or washed sand, whereas in our experiment it was a sand-soil mixture which is very likely to have supplied the B requirements of the tea cuttings.

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GROWTH OF TEA CUTTINGS UNDER COLOURED POLYTHENE

K. S. VENKATARAMANI

Polythene film has proved to be of some aid in the vegetative propagation of tea and its uses in this connection have been reviewed already (1). This versatile material is now being freely used in tea nurseries. We have had occasion to mention earlier that the yellow coloured film appeared to be superior to the colourless film, and we have now had an opportunity to examine the usefulness of the colourless, red and yellow films. Comparable cuttings from three tea clones were planted in a suitable rooting medium contained in small earthenware pots and the pots were kept in propagation chambers fitted with polythene film (200 gauge) of different colours. At the end of 24 weeks the cuttings were carefully lifted from the rooting medium and the shoot and root portions were separated, oven-dried and weighed. In general, all the three clones behaved in a similar manner. The data obtained from one clone are presented in the following table:

Colour of film	Dry weight of shoot per cutting (mg)	Dry weight of roots per cutting (mg)
Colourless	2255	639
Red	2315	578
Yellow	2648	641
Difference required for significance @ P: 0.01	162	Not significant

There was no visual difference in rooting amongst cuttings grown under a cover of colourless, red or yellow polythene, but the shoot growth appeared to be better under yellow polythene cover than under colourless or red polythene cover. The analysis of the dry weight data bears this out. Visser (2), in Ceylon, made an almost similar observation and remarked that yellow polythene as a cover was superior to the colourless polythene.

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EXPERIMENTS ON THE CONTROL OF TEA MITES IN SOUTHERN INDIA

(1961—1962 Field Trials)

N. R. ANANTHAKRISHNAN

Many acaricidal and insecticidal compounds are now available for mite control. The results of our investigations in 1961-1962 with some of them are presented in this paper.

Materials and Methods.

In all, the following 12 different formulations were tested:

TABLE I
Acaricides tested, their composition and source.

Acaricide	Composition	Source
Akar 338	25% w/w ethyl ester of Dichloro Benzilic acid E. C.	M/s. Tata-Fison Ltd., Bangalore.
Ekatin	0,0- dimethyl S-2- (ethylthio) ethyl phosphoro dithioate	M/s. Sandoz Products, Bombay.
Eradex	2,3 Quinoxaline Dithol Cyclic Trithio carbonate	M/s. Bayer-Agrochem, Bombay.
Kelthane	1,1-d, (p-chlorophenyl)-2,2,2-trichloro ethanol	M/s. Amritlal & Co., Bombay.
Malathion	0,0-dimethyl-s-(1,2-di (ethoxy carbonyl) ethyl phosphoro dithioate	M's. Bharat Pulverising Mills, Bombay.
Metasystox (R)	25% Dimethyl Ethyl Sulphoxy ethyl Thiophosphate	M/s. Bayer-Agrochem, Bombay.
Mitex	Para-chlorophenyl parachloro Benzene sulphonate	M/s. Bharat Pulverising Mills, Bombay.
Paramar	Diethyl Para Nitrophenyl thiophosphate	do do
Rogor 20	0,0, dimethyl S methyl carbamoyl methyl phosphoro dithioate	M/s. Tata-Fison Ltd., Bangalore..

Acaricide	Composition	Source
Sayphos	Triazinyl phosphate insecticide	M/s. I. C. I. India Ltd., Madras
Trithion	0,0-diethyl (s-p-chlorophenyl thiomethyl phosphoro dithioate	M/s. Mysore Insecticides, Madras.
4974	More like chlorinated hydrocarbon	M/s. Bayer-Agrochem, Bombay.

It was not possible to test all the 12 acaricides in a single trial and, therefore, for the sake of convenience, five experiments were carried out.

The acaricides were sprayed with the aid of low volume pressure retaining Holder Harriden sprayers using 60 to 125 gallons of spray fluid per acre, the volume of the spray fluid varying in different experiments. One and two rounds of spraying with each acaricide were done at varying intervals for different experiments.

Assessment of the intensity of the mite attack was made as follows:—

Red Spider: (*Oligonychus coffeae*)

12 leaf samples from each plot were collected at random as near the plucking surface as possible and the mite population was assessed by counting the live Red Spider in each leaf.

Purple Mite: (*Calacarus carinatus*)

12 samples of third leaves were collected at random from infested shoots following spraying, and two discs punched on either side of the mid rib of each leaf were examined for the number of living mites on them.

Scarlet Mite: (*Brevipalpus australis*)

Mite and egg populations were assessed both before and after treatment by sampling at random 12 shoots from each treatment, each shoot comprising the second and the third leaves collected from branches on which the older leaves were definitely known to be infested. The basal half of these leaves on which the mites usually crowd was examined for the number of mites and eggs present.

Experiment I was laid out in a field which was 26 months from pruning. In addition to check, 5 treatments were included in this experiment, each treatment comprising 6 replications in a latin square design. Each plot had 100 bushes with a guard row of untreated bushes between two treated plots.

Experiment II: This experiment was laid out in a second year field, with 6 treatments including control, each replicated 6 times. Each plot had 100 bushes with a guard row in between two treated plots.

Experiment III: The third trial was laid out in a third year field. The design of the experiment was again latin square with 6 treatments including control and 6 replications with 100 bushes in each plot. Each plot had a guard row of untreated bushes.

Experiment IV was conducted in a field due for pruning in 1962. In addition to check, 6 treatments were included in a randomised block design with 4 replications per treatment with 200 bushes per plot, having a guard row of untreated bushes between two treated plots.

Experiment V: This last experiment was also laid in a field due for pruning in 1962. The design was latin square with 5 treatments and 5 replications with 200 bushes per plot with a guard row of untreated bushes between two treated plots.

Results:

The data on the efficiency of acaricides at a selected period of sampling are given in tables 2, 3, 4, 5 and 6.

Experiment I: In this experiment (Table II) Mitex, Trithion, Sayphos, Malathion and 4974 were tested against Red Spider. All the formulations were sprayed at a rate of 0.1%, except Sayphos which was used at double the concentration, i. e., 0.2%. Only a single application was given at the rate of 125 gallons per acre. All the formulations were effective against Red Spider when observations were made after 7 days. But sampling done after a month revealed a steady build up of mites

TABLE II

Effect of a single acaricide application on Red Spider population.

Acaricide Treatment (Dilution in parts of water)	No. of living population and percentage reduction over check.			
	After 7 days		After one month	
Mitex 1 in 1000	19	96.1%	629	46.9%
Trithion 1 in 1000	14	97.1%	714	39.7%
4974 1 in 1000	16	96.8%	656	44.6%
Sayphos 1 in 500	46	90.1%	597	49.9%
Malathion 1 in 1000	19	96.1%	649	45.1%
Control	488		1184	

in all the treated plots, thus showing that residual effect had decreased considerably. A single application of any of these formulations is, therefore, not sufficient for achieving adequate control.

Experiment II: As a single application of acaricides, (Experiment I) failed to reduce the mite population to the desired extent, it was decided to investigate the effect of some acaricides with two applications at a lower rate of application. The following acaricides were tried against Purple Mite and Red Spider:— Eradex, Ekatin, Mitex, Malathion and Trithion. All the formulations were applied at the rate of 16 oz. in 100 gallons, except Ekatin, which was used at the rate of 16 oz. in 75 gallons. The application rates ranged from 50 to 60 gallons per acre. Two applications were made with an interval of a fortnight between them. Results (Table III) showed that Ekatin and Trithion were quite effective against Purple Mite. Mitex and Malathion also gave satisfactory kill, but Eradex failed to control

TABLE III
Comparative effect of different acaricides against Red Spider
and Purple Mite.

Acaricides and concentration	Living Purple Mite.			Living Red Spider.		
	24 hrs. after 1st appln.	7 days after 2nd appln.	37 days after 2nd appln.	48 hrs. after 1st appln.	9 days after 2nd appln.	38 days after 2nd appln.
Eradex 16 oz./100 gall.	290	140	189	32	25	171
Ekatin 16 oz./ 75 gall.	63	60	84	22	28	127
Mitex 16 oz./100 gall.	109	65	46	29	27	76
Malathion 16 oz./100 gall.	115	67	167	35	29	258
Trithion 16 oz./100 gall.	22	30	33	34	18	59
Control	970	1143	360	1166	993	841

efficiently. Against Red Spider, all the formulations were found effective. Observations made 37 days after the second application showed that Purple Mite population had built up considerably in Eradex and Malathion treated plots and to a less extent in Ekatin treated plots. Mitex and Trithion had a longer residual effect. Similar results were obtained in the case of Red Spider when sampling was done 38 days after the second application.

Experiment III: 5 formulations, namely, Kelthane, Sayphos, Paramar, Akar and 4974 were tested in this experiment. Kelthane and 4974 were applied at the rate of 1 lb. in 100 gallons. Paramar was applied at the rate of 8 oz. in 100 gallons and Sayphos at the rate of 2 lb. in 100 gallons. The rate of application was 125 gallons of spray fluid per acre. Two applications were given at an interval of one month. It was observed (Table IV) that all the formulations were effective against Purple Mite and Red Spider when sampling was done at intervals of 24 hours, 7 days and 15 days after the first application. The bushes treated with the two organophosphorus acaricides, Sayphos and Paramar, had more number of mites than those treated with Kelthane, Akar and 4974. Observations made a month after the first application showed that there was a rapid build up of population of Red Spider and Purple Mite in plots treated with Paramar and Sayphos. Sampling done 50 days after the second application indicated that there was a general reduction in the mite population in the experimental area and this may be due to rains received during the experimental period. In general, Kelthane, 4974 and Akar appeared to be superior to the two organophosphorus acaricides, Sayphos and Paramar.

Experiment IV: In this experiment, 5 acaricides were tested against Scarlet mite, namely, Akar, Kelthane, Paramar, 4974 and Malathion. All the formulations were sprayed at 0.1%, except Paramar which was sprayed at 0.05%. Two applications were given at an interval of 22 days, at the rate of 125 gallons per acre. Observations made 8 days after the first application showed that all the formulations reduced the mite population considerably. But in samples taken 20 days after the first application, the mite population increased steadily in plots treated with Malathion and Paramar. Mite population assessed a month after the second application also showed that the number of mites was more in Paramar and Malathion treated plots. Thus the residual effect of Paramar and Malathion was very poor. Akar, Kelthane, and 4974 gave better results (Table V).

Experiment V: This trial was carried out to evaluate the toxicity of systemic insecticides to Red Spider and Scarlet mite. Four systemic acaricides were included in the trial, namely, Sayphos, Ekatina, Metasystox and Rogor. Metasystox was applied at 16 oz. in 100 gallons, Rogor at 24 oz. in 100 gallons, Ekatina at 16 oz. in 75 gallons and Sayphos at 2 lb. in 100 gallons of water. Two applications were given at an interval of a month. The rate of application was 75 gallons per acre. Observations made on the 7th and 15th day showed that all the acaricides reduced the population of Red Spider, but with the sampling made 22 days after the first application, the population of Red Spider was seen to have increased considerably in Ekatina and Sayphos treated plots. In the case of Scarlet mite even the initial kill by Ekatina and Sayphos was very poor. Even with a second application, Sayphos and Ekatina were not found to give a satisfactory control. The results obtained with Rogor and Metasystox against both Red Spider and Scarlet mite were encouraging (Table VI).

TABLE IV

Effect of various acaricides on Red Spider and Purple Mite

Treatment and concentration.	Living Purple Mite.				Living Red Spider.					
	24 hrs. after 1st appln.	15 days. after 1st appln.	25 days after 1st appln.	10 days after 2nd appln.	50 days after 2nd appln.	7 days after 1st appln.	15 days after 1st appln.	1 month after 1st appln.	17 days after 2nd appln.	50 days after 2nd appln.
Kelthane 1 lb./100 gall.	32	15	32	18	32	39	36	34	34	56
Sayphos 2 lb./100 gall.	86	36	127	40	73	52	44	246	43	53
Paramar 8 oz./100 gall.	84	38	97	38	42	55	57	229	43	42
Akar 16 oz./100 gall.	17	10	35	10	41	34	45	89	25	83
4974 1 lb./100 gall.	22	18	22	13	37	53	50	124	34	37
Control -	683	680	697	447	212	810	1143	1143	1152	699

TABLE V

Effect of Akar, Kelthane, 4974, Paramar and Malathion on Scarlet Mite.

	Living Adults.			Eggs.		
	III Leaf	II Leaf	Total	III Leaf	II Leaf	Total
Pretreatment counts on 12 shoots	170	184	354	150	147	297
† 8 days after 1st treatment						
Akar-16 oz./100 gal.	18	19	37	15	14	29
Kelthane-1 lb./100 gal.	14	28	42	19	27	46
4974-1 lb./100 gal.	15	13	28	22	23	45
Paramar-8 oz./100 gal.	44	16	60	49	22	71
Malathion-16 oz./100 gal.	33	22	55	27	21	48
Control	172	100	272	297	213	510
† 20 days after 1st treatment						
Akar	*84	30	114	32	21	53
Kelthane	40	53	93	72	63	135
4974	27	30	57	47	52	99
Paramar	94	89	183	143	112	255
Malathion	127	131	258	127	113	240
Control	414	316	730	420	240	660
† 11 days after 2nd application						
Akar	24	26	50	11	16	27
Kelthane	**43	26	69	31	17	48
Paramar	30	24	54	22	15	27
4974	31	25	56	15	14	29
Malathion	33	16	49	22	19	41
Control	883	800	1683	477	438	915
† 1 month after 2nd application						
Akar	18	18	36	11	17	28
Kelthane	42	40	82	29	18	47
Paramar	168	111	279	159	40	199
4974	30	26	56	18	16	34
Malathion	124	140	264	80	89	169
Control	1730	1707	3437	1321	1377	2698

* In one shoot there were 39 mites

** In one shoot there were 19 mites

† Observations based on 40 shoots

TABLE VI

Number of Red Spiders and Scarlet mites on shoots treated with different systemic acaricides

RED SPIDER						
Treatment and concentration.	Pretreatment count.	8 days after 1st appln.	15 days after 1st appln.	22 days after 1st appln.	19 days after 2nd appln.	
Sayphos 2 lb./100 gal.	963	46	34	229	34	
Ekatin 16 oz./75 gal.	884	58	75	397	71	
Metasystox 16 oz./100 gal.	962	27	22	77	17	
Rogor 20 24 oz./100 gal.	969	33	17	110	23	
Control	840	999	720	890	412	
SCARLET MITE						
	Mites.			Eggs.		
	III leaf	II leaf	Total	III leaf	II leaf	Total
Pretreatment observation in 12 shoots	152	297	449	327	223	550
† 9 days after 1st application						
Sayphos	74	100	174	120	111	231
Ekatin	105	110	215	207	194	401
Metasystox	37	11	48	118	30	148
Rogor	36	38	74	110	103	213
Control	825	435	1260	1220	1300	2520
† 23 days after 1st application						
Sayphos	90	73	163	207	190	397
Ekatin	214	271	485	431	452	883
Metasystox	43	40	83	110	120	213
Rogor	43	51	94	122	114	236
Control	892	1005	1897	3350	2321	5671
† 15 days after 2nd application						
Sayphos	62	60	122	60	50	110
Ekatin	231	225	436	205	209	414
Metasystox	30	25	55	28	20	48
Rogor	38	30	68	35	26	61
Control	1930	1672	3602	1760	1428	3188

† Observations based on 60 shoots.

SUMMARY

1. Field tests were made in 1961-62 with three organophosphorus, five non-organophosphorus and four organophosphorus systemic acaricides for comparing their efficiency in controlling mites at various intervals and rates of application.

2. None of the five formulations, namely, Mitex, Trithion, Sayphos Malathion and 4974 gave satisfactory control of Red Spider when a single application was given and observations made after a month.

3. Ekatin and Trithion were effective against the Purple mite. Malathion and Mitex also gave a satisfactory control, whereas Eradex did not give a good control. Against Red Spider, all the formulations were found effective. Eradex and Malathion had limited residual effect. Ekatin had better residual effect when compared with Eradex and Malathion. Mitex and Trithion had longer residual effect than Ekatin.

4. Kelthane, Sayphos, Paramar, Akar and 4974 were effective against Purple mite and Red Spider. Paramar and Sayphos had less residual effect when compared with Kelthane, 4974 and Akar.

5. Kelthane, Akar and 4974 were superior to Paramar and Malathion in controlling Scarlet mite.

6. The systemic acaricides, Sayphos, Ekatin, Metasystox, and Rogor gave effective control of Red Spider, but the retention of toxicity was longer in the case of Metasystox and Rogor. Against Scarlet mite, Rogor and Metasystox gave effective control. Sayphos and Ekatin failed to control these mites effectively.

FIELD TESTS WITH INSECTICIDES FOR THE CONTROL OF FLUSHWORM OF TEA

N. R. ANANTHAKRISHNAN

Earlier trials have shown that DDT and Malathion are effective in the control of flushworm (1). Recently five insecticide formulations were tested, namely, Folidol E 605, Malathion 50 E. C., W. L. 1650, DDT 50 WP, and Sevin 50 W in two experiments. The results are presented in this paper.

MATERIALS AND METHODS

Two experiments were carried out in a field one year from pruning. In the first experiment, 3 formulations were tested along with an untreated control, and the experiment consisted of 16 plots, each of 100 bushes. The treatments were replicated four times. In the second experiment, 5 formulations were tested; each treatment was replicated 6 times and each experimental plot consisted of 100 bushes.

Two spray applications were given at the rate of 40 gallons of the spray fluid per acre. In the first experiment, the interval between the two applications was 17 days, and in the second experiment it was 9 days. The bushes were harvested at periodic intervals and shoots harvested were examined for flushworm infestation. The assessment of the intensity of attack was made by counting the number of infested shoots at each harvest, and for comparison purposes the data were expressed on a per pound basis. The results are presented in the following tables:—

EXPERIMENTAL RESULTS

Experiment 1

TABLE 1

Number of infested shoots per pound of green leaf

Treatment.	9 days after 1st application.	17 days after 1st application.	11 days after 2nd application.	22 days after 2nd application.
Sevin (1.5 lb./100 gal.)	68	55	45	51
DDT 50 WP (1 lb./10 gal.)	55	37	19	34
WL 1650 (0.5 lb./acre)	56	49	32	47
Control (Untreated)	79	71	62	57

TABLE 2.

Percentage reduction in number of infested shoots in the second to the fourth plucking over the infestation in the first round of plucking.

Treatment.	Plucking rounds.		
	2nd	3rd	4th
Sevin	19.12	32.35	25.00
DDT	32.73	65.45	38.18
WL 1650	12.50	42.86	16.07

All the formulations did control flushworm infestation, but DDT afforded the best protection against the pest. The residual effect of DDT was worthy of notice, but even that was not marked after a period of three weeks.

Experiment 2:

TABLE 3.

Number of infested shoots per pound of green leaf.

Treatment.	7 days after 1st application.	5 days 14 days 25 days 32 days after 2nd application			
DDT (1 lb./10 gal.)	68	57	35	31	36
Folidol (0.5 lb./100 gal.)	62	56	25	29	37
Sevin (1.5 lb./100 gal.)	83	72	50	47	45
Malathion (0.25 lb./10 gal.)	67	58	45	49	41
WL 1650 (0.5 lb./acre)	81	77	55	59	39
Control (unrestricted)	111	128	82	58	47

TABLE 4.

Percentage reduction in number of infested shoots in the 2nd to 5th plucking over the infestation in the first round of plucking

Treatments	Plucking rounds.			
	2nd	3rd	4th	5th
DDT	16.17	48.61	54.41	47.05
Folidol	9.67	59.67	53.22	40.32
Sevin	13.25	29.75	43.37	45.78
Malathion	13.43	32.83	26.86	38.80
WL 1650	4.98	32.09	27.16	51.85

These results show that DDT and Folidol have given better protection than the other treatments. DDT has again shown to have a longer residual effect.

CONCLUSIONS

It would appear from the above trial that none of the insecticides tested has proved highly effective in the control of flushworm. DDT and Folidol gave fairly satisfactory control and DDT had a longer residual effect than others.

In the control of flushworm, it should be emphasised that timing, frequency and rate of application of the insecticides are important. The peak attack of flushworm in Central Travancore has been observed to occur during the period November to January. A thorough spray application with a residual insecticide, such as DDT, in September/October, during the break in the monsoon rains, can be expected to check the build up of flushworm population and thus prevent crop loss.

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